Engineering News

VOLUME 71 MARCH 26, 1914 NUMBER 13

The Wichita Union Station

By C. J. Skinner*

SYNOPSIS—At Wichita, Kan., four railway companies had parallel and adjacent lines across the city, at the street level. The accompanying article describes the replacement of these by a four-track elevated line with a union station and the construction of a long street viaduct over the railway tracks and yard.

Track elevation and terminal facilities are being provided at Wichita, Kan., at a cost of about $2,000,000. This work is being done by the Wichita Union Terminal Ry. Co., which was organized for the purpose by four of the six railways entering the city; namely, the Atchison, Topeka & Santa Fé Ry., the Rock Island Lines, the St. Louis & San Francisco Ry., and the Kansas City, Mexico & Orient Ry. The railway lines in the city, with the new elevated terminal line and the union station, are shown in Fig. 2.† The station is to be opened in March.

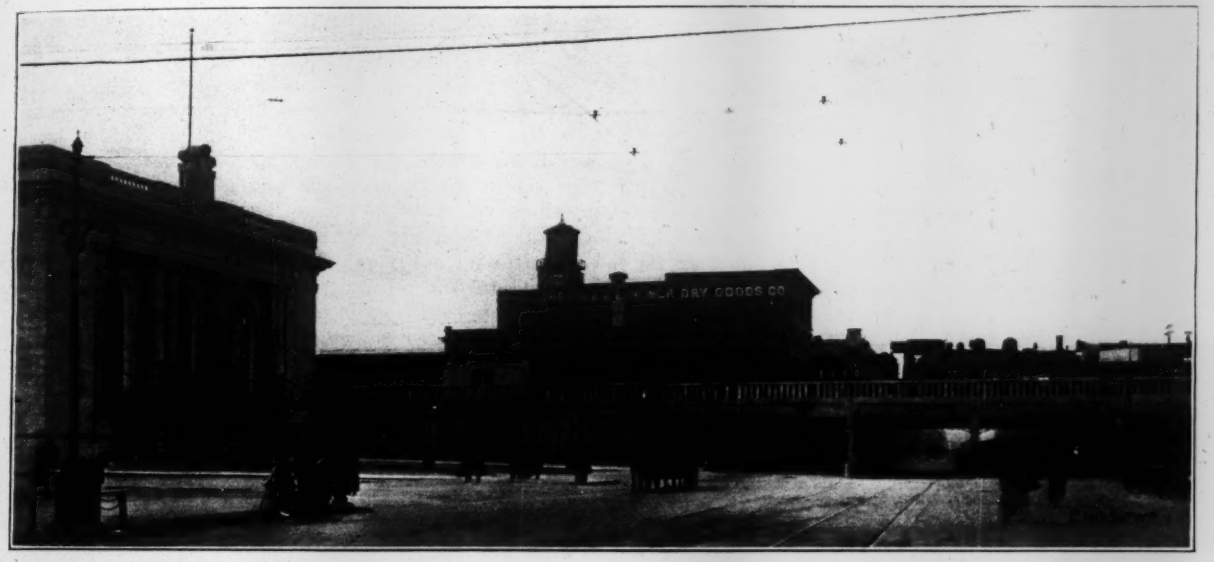

Fig. 1. Union Station and Douglas Ave. Subway, Wichita, Kan.; Wichita Union Terminal Ry.

General Description

Douglas Ave., which is the principal business street, is crossed at grade by the main lines of the first three railways within a distance of two blocks. The center of the city is about six blocks west of this point and there is a rapidly growing residence district on the east side of the tracks. The primary object of the elevation is to abolish the grade crossings on Douglas Ave., and the ordinance provides that all of the surface tracks shall be removed from this street.

Although the work has been an expensive proposition, it has been carried out at less cost than would have been incurred under average conditions. This is due to the fact that south of Douglas Ave. there is a territory occupied by railway yards, and there are no open streets across the tracks between Douglas Ave. and Kellogg St., a distance of half a mile. North of Douglas Ave., the streets are spaced 600 ft. apart. Owing to these conditions, the elevation of the tracks involved the construction of only three subways and one viaduct, and only one street was closed.

Another thing which allows the track elevation to be done at moderate expense is the fact that the lines of the four railway companies are parallel to each other and only a short distance apart (Fig. 2). At the south end of the track-elevation work, the Orient and Rock Island lines cross the Santa Fé; while at the north end there is a Y-connection between the Frisco and the Santa Fé. This has allowed the track connections to be made with a minimum of expense.

Subways have been constructed at Douglas Ave., 1st St. and 2nd St.; 3rd St. is closed and Central Ave. is left open, the raise at this point being about 2½ ft. The height of the elevation is fixed by the clearance at Douglas Ave., and at this point there is a clearance of 13½ ft. above the street-car tracks and 12 ft. above the roadways. There is 12-ft. clearance at 1st St. and 10-ft.

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†The Missouri Pacific Ry. has an old station, but with adequate facilities. The Midland Valley R.R. has a new station; this road operates only a few trains. The city has a population of about 63,000.—Editor.

clearance at 2nd St. It was originally proposed to close the latter street, but as a compromise a subway was provided with a clearance of only 10 ft. The following statement shows the clearance at the various subways and the amount the roadways are depressed.

Street	Clearance	Depression
Douglas Ave., roadways	12 ft. 0 in.	1 ft. 6 in.
Street railway	13 ft. 6 in.	3 ft. 0 in.
First St., roadway	12 ft. 0 in.	2 ft. 0 in.
Second St., roadway	10 ft. 0 in.	2 ft. 0 in.

The Douglas Ave. subway is 114 ft. wide, and includes a double-track street-car line, two 29-ft. roadways and two 12-ft. sidewalks. The other two subways have a 31-ft. roadway and two 5-ft. sidewalks (Fig. 1).

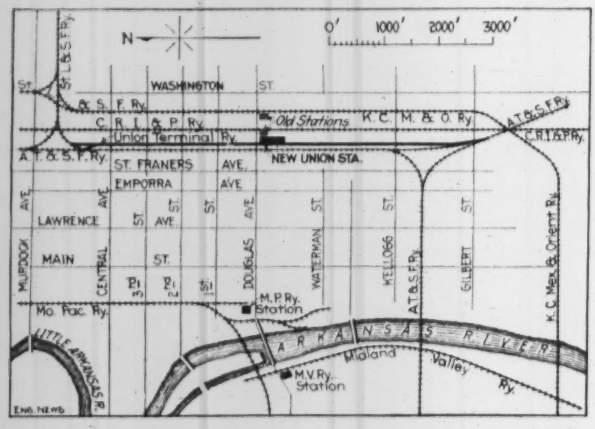

FIG. 2. MAP OF RAILWAY LINES AT WICHITA, KAN., SHOWING THE NEW ELEVATED TERMINAL LINE AND UNION STATION

The maximum grade used for the main lines on the track elevation is 0.6%, as shown in Fig. 3. Along the platforms at the station the grade is 0.2%, the maximum grade being beyond the south end of the platforms. Between Douglas Ave. and 2nd St., the grade is fixed by the clearance of the subways, and the maximum grade is used north of 2nd St. At Douglas Ave., the roadways are depressed 1½ ft. and the street-car tracks 3 ft. below these. The depression at the [illegible] is scarcely noticeable. The sidewalks are carried [illegible] grade. There has been no trouble in securing [illegible] for the subways, although the city is naturally [illegible]

Practically the entire cost of the track elevation has been borne by the railways. The city's share of the expense is the cost of lowering and paving the streets and building the sidewalks under the subways; also the cost of incidental and consequential damages to the [illegible] property or business, due to the elevation of the tracks or to the depression or vacation of streets. The city, however, pays 33% of the cost of the Kellogg St. viaduct across the tracks, the remainder being paid by the terminal company.

TRACK PLAN

A four-track main line has been built the entire length of the elevation, a distance of 1½ miles, and at the station the two passenger main lines spread out into five through passenger tracks, as show nin Fig. 3. The track plan also provides for three spurs just south of the station. This makes ten tracks on the elevation south of the station, and seven tracks across Douglas Ave.

Provision has been made for two additional future tracks along the west side of the elevation. The retaining-wall along this side has been omitted, there being only a toe-wall along the slope. When additional tracks are needed, the retaining-wall can be built on the west side, and (by doing a small amount of grading) the additional tracks can be put in.

South of the passenger spurs, there is a coach yard which will hold 23 cars. There are also several short spurs at each end of the station tracks which will be convenient for use in connection with the switching of Pullman cars and other cars on or off of the regular trains. Two complete electric interlocking plants are being constructed, one at each end of the elevation.

The track arrangement is so planned that any of the five passenger tracks at the station can be entered from either end (Figs. 2 and 3). At the south end, the two

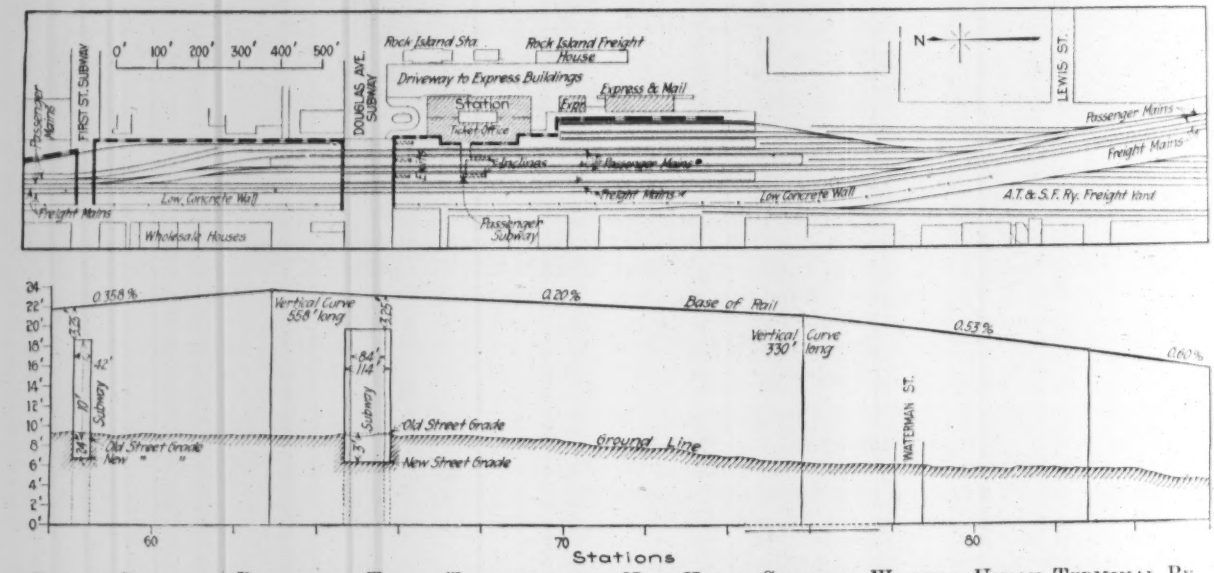

FIG. 3. PLAN AND PROFILE OF TRACK ELEVATION AND NEW UNION STATION; WICHITA UNION TERMINAL RY., WICHITA, KAN.

east tracks of the four-track main line are connected with the Santa Fé main lines and the two west tracks are connected with the Rock Island lines. This will allow a four-track movement being made over the crossing of the Oriental railway. Similar provision is made at the north end, so that a four-track movement can be made at the point where the Rock Island and Frisco tracks diverge from the Santa Fé. The passenger tracks at the station could easily accommodate 20 trains an hour, while at the present time the four railways have 30 trains a day only. This excess capacity is due to the fact that at the station there are probably two tracks more than are needed at the present time, but the additional grading and the laying of these two tracks is only a small proportion of the total cost.

Subways and Viaduct

The subways are of steel construction, with a concrete deck, but having the outside columns and beams incased in concrete to harmonize with the design of the adjacent retaining-walls. The abutments are of 1:3:6 concrete with spread footings. Fig. 1 shows the Douglas Ave. subway, having three roadway spans and two sidewalk spans. It is surmounted by a concrete railing. Beyond it is the retaining-wall of the track-elevation work, and at the left is the main front of the new station. Fig. 4 shows the First St. subway. At each curb line are steel columns carrying a cross-girder, the span is formed as a self-supporting deck of longitudinal 20-in. I-beams, spaced 17 in. c. to c., resting on the abutments and the cross-girders.

Fig. 4. Subway at First St., Wichita Union Terminal Ry. Steel Columns and I-Beams. Ends Incased in Concrete

Fig. 5. The Kellogg St. Viaduct, Wichita, Kan., Showing Stairway Approach and Concrete Railing

These spans are designed for Cooper's E-60 loading. The exposed steel work is painted a battleship gray.

On the I-beams is a 4½-in. concrete floor, reinforced both with rods and triangular mesh reinforcement. Above this floor is a 2-in. asphaltic waterproofing coat, which consists of a priming coat, three layers of saturated burlap and 1½ in. of asphaltic mastic. Upon this floor is laid broken-stone ballast 6 in. deep under the ties, 12 in. of stone ballast being used on the fills between the bridges. The distance from the base of the rail to the bottom of the 20-in. I-beams is 2 ft. 8½ in.

The Kellogg St. viaduct is 2000 ft. long, crossing not only the terminal company's tracks but also the yards and tracks of the main railway systems. It is of reinforced-concrete construction, with the exception of six steel spans which are used to provide a minimum distance from the pavement to the bottom of the girders at the controlling points. Across the yards a three-track span is used. The viaduct has a 26-ft. roadway and one 5-ft. sidewalk, and its maximum grade is 6%. It is designed to carry a 20-ton road roller. Fig. 5 is a view of the viaduct at St. Francis St., showing the reinforced-concrete railing and the stairway approach from the street.

The minimum vertical clearance over the tracks is 22 ft., and the minimum horizontal clearance is 8½ ft. from the centers of tracks. At the east end of the viaduct, the distance between the main line of the Orient railway and Washington Ave. is so small that it was necessary to depress the track 1½ ft. and raise the street 2 ft. A one-track I-beam span is used over the Orient track; the next span west of this is a two-track I-beam span, followed by a three-track steel girder span, which last is incased in concrete. The 6% grade allows the next span to be of reinforced-concrete. The following table gives the distance from the pavement to the bottom of the beams of the various spans.

Span	Length	Distance from Pavement to Lowest Part of Beams
One-track, steel	22 ft.	9 in.
Two-track, steel	32 ft.	1 ft.
Three-track, steel	53 ft.	1 ft. 4½ in.
One-track, concrete	19 ft.	2 ft. 3½ in.
Two-track, concrete	32 ft.	2 ft. 9 in.
Three-track, concrete	45 ft.	3 ft. 6 in.

The viaduct and the subway bridges will be described more fully in a subsequent article.

Union Station

The station is 260x100 ft. and is set back 80 ft. from Douglas Ave., as shown by Fig. 2 and by the larger plan, Fig. 6. The curved drive in front of the station is used by carriages in bringing passengers to the station, and there will be a carriage stand along the east side, as shown. A 40-ft. roadway east of the station provides access to the baggage room and to the buildings of the three express companies. Passengers will reach their trains by means of subways under the tracks, with inclines leading to each platform. In this way all crossing of tracks can be avoided.

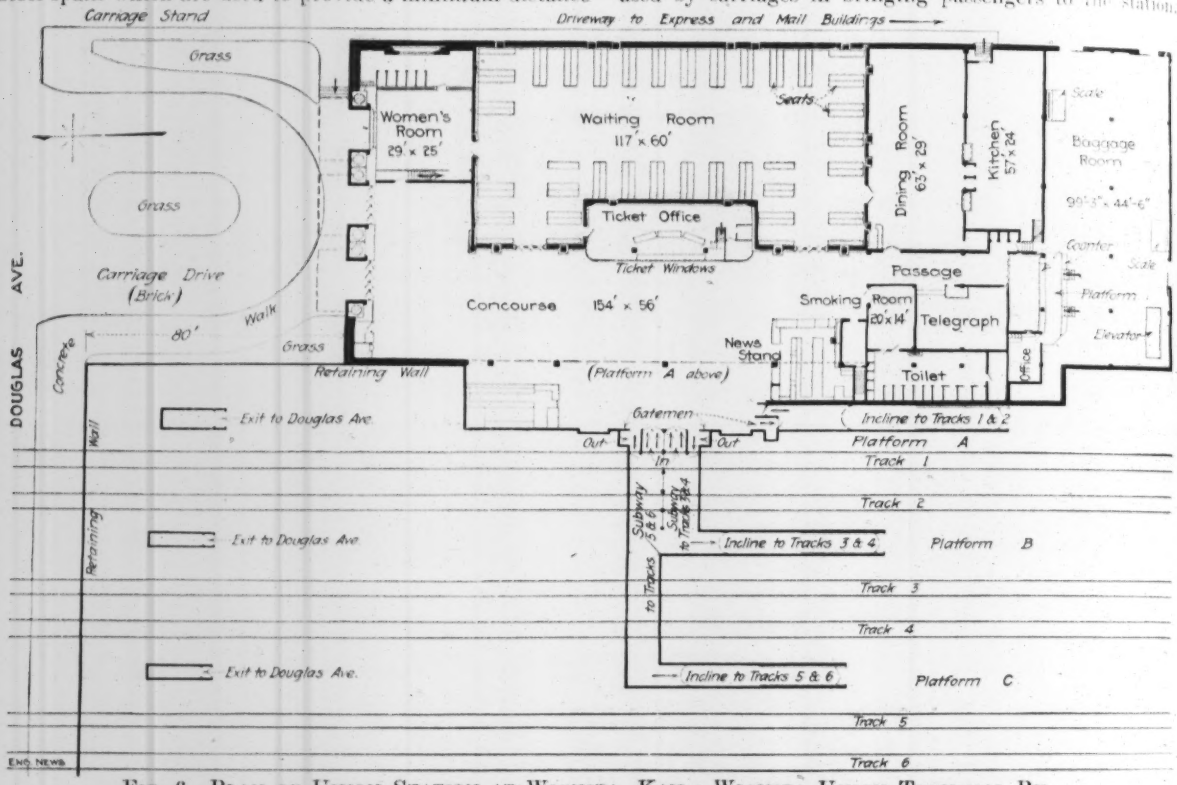

FIG. 6. PLAN OF UNION STATION AT WICHITA, KAN.; WICHITA UNION TERMINAL RY.

(The tracks are elevated and the station facilities are at the street level.)

The track platforms are 19 ft. wide and spaced 28 ft. c. to c. of tracks. The maximum length of platforms is 900 ft., but this can be increased to 1100 ft. The minimum spacing of tracks is 13 ft. No trainshed or platform shelters have been erected as yet, as it would be necessary to place them on a 14-ft. fill. After this fill has been allowed time to settle it is probable that umbrella shelter roofs will be built, either of reinforced concrete or of structural steel incased in concrete.

The platforms are only 10 ft. above the floor of the

station, and this is the ideal arrangement for a through station. Where the waiting room is on a higher level than the tracks, it is necessary for elevators to be provided, or for the passengers to climb a flight of stairs some 25 ft. in height. In this case it is necessary to provide clearance over the tracks for a train, while at Wichita it is only necessary to provide clearance under the tracks for a man. The Wichita arrangement is much better than any subway arrangement which could be provided in case the waiting room and tracks are on the same level. In this case, two flights of stairs or inclines are necessary.

In many of the older stations the waiting room is long and narrow and is used not only as a waiting room but as a passageway by passengers going from the ticket office to the baggage room and to the other necessary facilities. By making the Wichita station 100 ft. wide it was possible to secure a very convenient arrangement. The main waiting room, which is 120x65 ft., is on the east side of the station and need not be entered except by passengers who wish to sit down and wait for their trains. The ticket office fronts on the concourse and passengers transact all their business in this concourse without going to the waiting room.

From a central point in the concourse, it is only a short distance to the ticket office, baggage room, telephone booths, telegraph office, dining room, waiting room, news stand and the parcel checking room. It will be seen that these facilities are grouped about the concourse as a center in a very convenient manner. Fig. 7 is a view of the concourse, with the ticket windows and waiting-room door at the left, and the entrance to the platform subways at the right. The door at the rear is in the passage giving access to the smoking, dining and baggage rooms. Fig. 8 is a cross-section through the station concourse and elevated tracks.

The west wall of the concourse is a retaining-wall and a portion of the concourse extends under the track platform. Both the retaining-wall and the track platform are thoroughly waterproofed. An elevator is provided for the baggage room and two elevators for the express companies. These are so arranged that if found desirable, the greater part of the handling of the baggage and express can be done on the platforms next to the station, without interference with that portion of the platforms used by passengers. There are also exits or subways leading directly from the track platforms to the sidewalk under the Douglas Ave. subway. These exits are provided with turnstiles which permit of egress only.

The first building beyond the passenger station (Fig. 3) is an express building 70x40 ft.; next to this is a mail and express building 165x40 ft. At the ground level these have a trucking space 14 ft. wide under the main platform. Those buildings are finished in bush-hammered concrete and vitrified brick.

The Douglas Ave. front of the station is built of a handsome white stone (Turkey-Creek stone, from Pueblo, Colo.) and the east and west elevations are of terra-cotta. Fig. 1 shows the main front on Douglas Ave., with the bridge carrying the elevated tracks. The interior of the station is finished in terra-cotta. Practically the entire west side of the concourse is composed of windows, and the effect of this is to make the room very light and cheerful. The walls and ceilings are decorated in yellow and blue. The floors are of marble throughout.

The passenger subways and inclines have marble floors

FIG. 7. CONCOURSE OF THE NEW UNION STATION AT WICHITA, KAN.
(The ticket windows are at the left, beyond the door to the main waiting room. At the right is the entrance to the subway from which inclines lead up to the train platforms.)

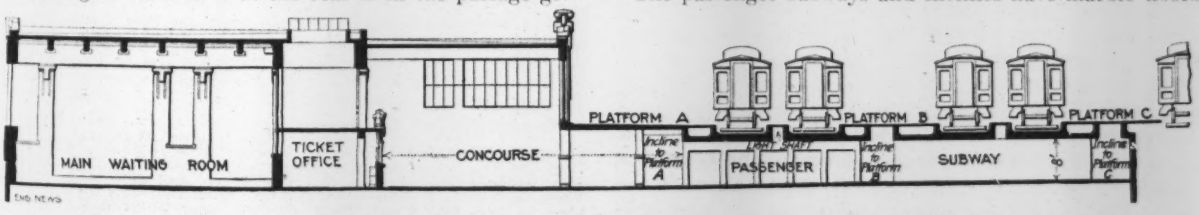

FIG. 8. SECTION THROUGH THE NEW UNION STATION AND TRACK ELEVATION AT WICHITA, KAN.

and a tile wainscoting and are as light and attractive as any portion of the building. Platform lights are provided in the ceilings of the subways. The architect of the station is Louis Curtiss, of Kansas City.

Grading and Drainage

The embankment of the track elevation is of sand, which was pumped from the Arkansas River and hauled in large railway dump cars to the site of the work. Sand was used for this purpose in order to secure a minimum settlement after the fill was completed. On account of the number of track platforms opposite the station, the settlement which would have resulted from making a dirt or clay fill would have made the cost of maintaining the tracks and platforms very expensive after the fill was completed. The average settlement of the sand embankment was between 1 and 2%.

Special attention has been paid to drainage, and a complete system of drain lines and manholes has been provided, the drains connecting with the city sewer system. A 6-in. drain with open joints was laid along the track side of the retaining-wall to provide good drainage for the footings, and a similar drain was put about 3 ft. below the top of the wall, the latter being laid in wooden troughs so as to prevent settlement. Similar drains were provided at the back of the abutments. Weep holes were placed in the retaining-walls at intervals of 12 ft. The retaining-walls were built in 30-ft. sections, and the joints between these sections were waterproofed.

A blanket of earth has been placed along the slopes of the embankment and this has been sodded to prevent wash. Bermuda grass and alfalfa were used for the east slope of the embankment south of the station. The cost of sodding a half-mile of this slope was about $300, the height of the fill varying from 2 ft. at one end to 14 ft. at the other. On account of the danger of the Bermuda grass being winter killed, manure was spread over the slope at an additional cost of $80. A woven-wire fence is being built along both slopes of the embankment to prevent trespassing. This fence is 6 ft. high and has a barbed wire strung along the top. The woven wire is of a type which makes it difficult for climbers to secure a toe-hold.

Construction and Progress

Practically the entire work was let by contract. The Texas Building Co., of Fort Worth, Tex., had the construction of the retaining-walls, the subways, the Kellogg St. viaduct and other concrete work. Kilpatrick Bros., of Beatrice, Neb., had the grading and track laying. The station and associated buildings were built by the Dieter & Wenzel Construction Co., of Wichita. The work is practically finished, the construction work having occupied only about 18 months. Before the contracts were let, practically every detail was considered and covered by plans and specifications, so it was possible to let the entire work by contract and carry on the various portions of the work simultaneously.

The driving of 600 concrete piles along the east retaining-wall was done in 28 working days, there being concrete piles along the walls for a distance of 1900 ft. These piles were spaced about 3 ft. apart, the minimum spacing being 30 in. c. to c. In connection with the grading, a trestle was constructed along the east side of the elevation and after this was filled the track was thrown to the west until the embankment was completed. The sand for this fill was pumped into [illegible] cars by two local concerns; the Kansas Construction Co. and the Orient Sand & Cement Co. One 8-in. and two 10-in. pumps were used in this work, and a maximum of 3000 yd. per day was pumped. A total of 50,000 [illegible] was pumped in June.

Tracklaying was started Oct. 1, and is practically completed. About 20,000 yd. of stone ballast have been laid. About 210,000 yd. of concrete have been used in the various structures.

The work is being constructed on the right-of-way, the greater part of which was purchased from the Santa Fé Ry., and it was necessary to carry on the work with a minimum of interference with this railway's traffic. At the time the retaining-walls were started, this traffic was thrown to the extreme west side of the right-of-way and a temporary main line constructed north from Douglas Ave. This allowed the retaining-walls and a greater part of the subways to be completed without any interference with the main-line business. In October, the Santa Fé Ry. traffic was transferred to the elevated tracks, and the railway was provided with temporary quarters on the second floor of the station. This allowed the old Santa Fé station and express buildings to be torn down, so that the concrete work and grading just south of Douglas Ave. could be completed.

Engineers

The writer has been in charge of the entire work since the organization of the terminal company, reporting to a board of engineers, of which C. F. W. Felt, Chief Engineer of the Santa Fé System, was chairman. The representatives on this board of engineers of the other railway companies were J. M. Brown, Engineer of Maintenance-of-Way of the Rock Island; M. C. Byers, Chief Engineer of Operation of the Frisco (who was succeeded by V. K. Hendricks, Assistant Chief Engineer); and W. W. Colpitts, Chief Engineer of the Orient Ry. (who was later succeeded by H. Holmes).

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A Classification of Maintenance-of-Way Expenses is proposed by the Committee on Records and Accounts in its report presented at the annual meeting of the American Railway Engineering Association. This is a subdivision of account No. 6 ("roadway and track") in the Interstate Commerce Commission classification of operating expenses, and includes ten items, as follows: 1, Track maintenance; 2, applying track materials; 3, cutting weeds and general cleaning; 4, ditching and bank widening; 5, changing grades and alignment; 6, flood damage; 7, bank protection; 8, filling; 9, other care of roadway and track; 10, work-train service. This subdivision is designed to enable the officer in charge to determine the efficiency of the section gangs, to analyze expenses and to effect economies.

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County Bridge Building in New Jersey in 1834—A slip of paper, yellow with age, which illustrates the method of letting contracts for bridge construction and repairs in New Jersey 80 years ago, is sent to us by H. G. Moulton, of Eugene Meyer, Jr., & Co., 14 Wall St., New York City. It appears to have been the practice in New Jersey at that time to call together the selectmen and various carpenters at the site of the bridge to be constructed or repaired, and to auction off the job to the lowest bidder. A verbatim transcript of this old-time notice is as follows:

Henery Haney
you are Herein Notified to meet at Beatyes Town on Satterday the 16th Day of August first at 1 oClock of sd. Day for the purpose of Viewing and selling the repairs of two Bridges the one at Beatyes Town and the other Near Thomas Martin's House Across the Muscunetcong Creek and also to sell one small New Bridge Near John Stephens In Washington August 5th 1834
John L. Slicken, Over Seeer of the Road

Internal Stresses; With Application to Reinforced-Concrete Beams

A Series of Three Related Papers, with Diagrams. III—Reinforced Concrete

By Charles A. Gilchrist*

SYNOPSIS—Discusses concrete reinforcement in the light of the theory of trajectories of principal stress. A design embodying this theory is shown; the structure is now being built.

The idea of principal stresses and their trajectories suggests a natural theory for reinforced concrete.

It is the usual idea that the trajectories for the homogeneous beam are perhaps the ideal criterion for the placing of steel in a reinforced-concrete beam, but the thought never seems to be followed up, because the introduction of steel alters the elastic conditions which determine the trajectories themselves, thus presenting a problem whose answer is involved in the premise and whose solution on reasonably strict lines presents almost insuperable difficulties. But the mathematical insolubility of this problem does not vitiate the theory. The idea that steel rods *should* follow the final lines of principal stress is the only comprehensive theory we have as a basis for designing reinforcement. If we cannot determine rigidly what distribution of steel *will* conform to these final directions of principal stress, then we must determine it approximately. The homogeneous beam must be our initial solution upon which to graft such modifications as are possible.

General directions of principal stress can usually be apprehended without any computations, and the effect of the presence or absence of steel can usually be considered as a mere "perturbation" from these general directions. As an instance, take the beam. We know that steel as ordinarily introduced will raise the neutral axis, causing somewhat greater curvature in the trajectories near the top than near the bottom. But this "perturbation" will not alter the general "flow" in long curves convex downward for tension and convex upward for compression. If the steel is made to follow these curves in only a general way, its direction cannot be far from the actual direction of principal stress.

The ideal reinforced body is a solid matrix in every part of which are embedded infinitely small steel fibers in such a way that their direction and "ratio of cross-section" at any point is a continuous function of the coordinates of the point, there being no angles, intersections, or abrupt changes of any kind. Insofar as the fibers are infinitesimal, such a mass may be regarded as homogeneous, provided the ratio of steel to matrix is constant throughout. Insofar as the elasticities of the two materials are different the composite is not isotropic.

By the "ratio of cross-section" or "ratio of steel" in such a body is meant the limit of the ratio of steel area to sectional area as the sectional area becomes indefinitely small. For any point this ratio would be the same whether the sectional plane were taken perpendicular to the fibers or inclined, and it would also be the same as the ratio of volume. It should be observed that the continuity of the fibers is a matter of no consequence, and the steel ratio may vary by a change of section in the fibers, by a gradual introduction of new fibers, by a convergence of fibers or by all three methods together. The question of bond does not arise, because the bonding surface becomes infinitely great when the fibers are infinitely small.

In a stressed body reinforced in this ideal way we may deal with the stresses at any point as though the body were homogeneous; for, the laws of the variation of stress at a point will apply if we interpret unit-stress to mean the limit of the ratio of combined steel and matrix stress to area, as the area approaches zero. Even though the steel ratio is not constant, and even though we make no condition that the fibers shall conform with the direction of principal stress, there will be everywhere two directions of principal stress whose distribution may be indicated by a system of trajectories.

For purposes of practical design it must be our object to make the steel conform as nearly as possible with the direction of principal tension that exists *with the steel present*. Concrete is to be assumed absolutely without tensile resistance, and the principal stresses are assumed everywhere of opposite sign. The steel fibers are to be considered as finite in number and size but still sufficiently small to allow us to regard the mass as approximating the ideal constitution. Under these conditions the action between steel and concrete will be as described in the following.

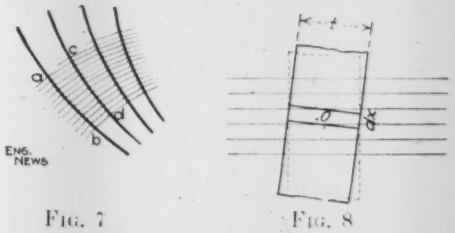

Fig. 7

Fig. 8

Fig. 7. Stress Relation of Reinforcing Rods and Elementary Concrete Struts. Fig. 8. Shearing Stress in Reinforcing Rod.

Fig. 7 illustrates the action. We refer only to the stresses parallel to a given plane.

The stress in the steel may be regarded as direct tension in the direction of its length, which—through elongation in the steel and lack of tensile resistance in the concrete—separates the concrete into innumerable short struts extending straight from bar to bar. The sides of these struts being free surfaces, the stress in the struts must be purely linear also, i.e., direct compression. Thus, the stress in both steel and concrete is direct, not compound (the compressive stress transmitted laterally through the rods is neglected, since it is very small in comparison with the major tensile stress).

The slight change in the direction of the compression at each rod takes the place of the curvature in infinitely close spacing of the rods; the short struts may be looked upon as chords of the compression trajectories. Such being the case the struts make approximately equal angles

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on opposite sides of the rods. It will now be apparent that *increments to either principal stress are made possible only by the curvature of the other.*

A pair of struts on opposite sides of a rod is like the two links of a toggle whose resultant pressure is the increment or difference in the steel tension on either side of the struts. Or, we may consider this increment as the sum of two equal shears which act through the bond at the surface of the rod. This bond surface considered as a plane section of the strut will have a shearing stress upon it because it is not perpendicular to the strut. This shear is the *combined* shear inherent on sloping planes in all direct stress members; it must not be confused with simple shear or so-called "shearing planes" which pertain only to a compound state of stress. In the space between the rods in a direction perpendicular to the figure, the concrete struts must be considered as abutting against each other at the same slight angle, and their resultant toggle action is transmitted to the steel through the bond on the other two of the four sides of the rod. The secondary lateral stresses here involved are only increments transmitted very short distances and may be neglected.

substantiating what has been said of the "pre[illegible]action between the two materials.*

Fig. 8 represents a portion of an embedded [illegible] bar. Shearing stresses on transverse planes of this [illegible] can be developed only when "overturning" of the bar [illegible] resisted by the bond on its sides. Clearly, if the bar [illegible] in a greased hole it could in no wise assist in re[illegible]ing any tendency of the concrete to shear over on plan[illegible] as indicated by the series of parallel lines.

Considering the equilibrium of the external [illegible]s acting on the thin section of the bar, having a thickness dx, we have the moment of the shear couple st^2dx, opposed by the resisting moment of the bond. This is applied on a strip dx, extending around on the four sides of the bar with the neutral point at O. Call b the unit bond, and equating moments:

$$st^2dx = (2\,tdx)\,\tfrac{1}{2}\,tb + (2\,tdx)\,\tfrac{1}{4}\,tb$$
$$s = \tfrac{3}{2}\,b$$

Since the shearing strength of steel is about 150 times the adhesive strength between steel and concrete, it follows from the above equation that only $\frac{1}{100}$ of the shearing strength of steel may be utilized to resist trans-

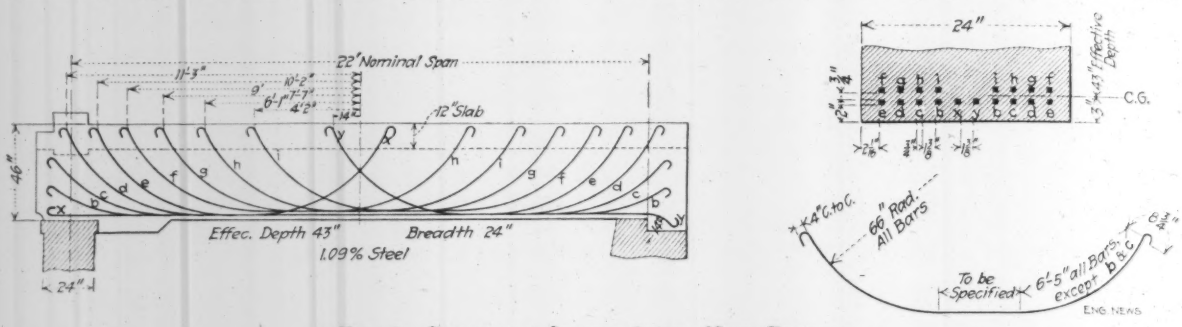


FIG. 9. BEAM FOR ILOILO QUAY, NEW PROJECT
(Beams are perpendicular to waterfront, and spaced 10 ft. c. to c.)

The curvature of the steel bars provides an increment in compression for a double reason. In addition to an increment from causes similar to those just discussed, there is an increment due the reduction in sectional area of the struts themselves. Thus, cd being less than ab, the unit-pressure upon it is greater than upon ab, even though there were no increment from the rod ab. But observe that cd must equal ab if the rods are straight. Hence: *either principal stress is constant if the other is straight.*

If it were literally true that concrete offered no tensile resistance, the foregoing "picture" of the action between the two materials would be the only possible action. In such a case the structure could be considered in equilibrium of an unstable sort, and the slightest disturbing force would utterly destroy it, for a substance without tensile resistance is without cohesion and as a rigid body is only hypothetically possible. But if we *design* for action such as has been described, all the calculable or primary stresses will be accounted for, and such tensile strength as the concrete offers will fulfill a distinctly secondary though necessary function.

If the steel does not follow a principal stress, then there must be shearing stresses in the rods on planes perpendicular to their length. It is now to be shown that such stresses cannot exist except to a negligible extent, thus

verse shear in embedded bars, and this is scarcely better than if the place of the steel were occupied by concrete.

The foregoing is affected somewhat by the shape of the cross-section of the rod, but not enough to alter the general conclusion that the shearing resistance of the steel is altogether negligible. This conclusion is unaffected by the size of the rods.

It may be objected that the couple st^2dx may be neutralized by bending couples in the rod. Such a neutralizing couple may exist only as the increment in each strip of a constantly increasing bending moment; but that such bending moments accrue over any appreciable lengths is hardly conceivable for an embedded rod. That such independent bending action in the bars plays no part in reinforcing is further evident when we consider that allowable shearing stresses in the steel will develop the allowable bending stresses on a length of arm about one-third the depth of the bar.

* * * * * *

Fig. 9 shows a reinforced beam that is designed with more than usual regard to the underlying theory of reinforced concrete, and yet it involves no sacrifice to any practical consideration. The structure of which this beam is a part is a quay now being built along the river front at Iloilo, P. I. It was designed by the writer under

*See also Mörsch, "Concrete-Steel Construction," p. 149.

the appr[illegible] of K. S. Heck, the Chief of the Division of Port Wo[illegible] The beams rest on a shallow wall at the inshore end and at the outer end they rest on reinforced-concrete columns placed over pile clusters.

The amount of steel in the beam was made such as to take all the diagonal tension along the neutral axis

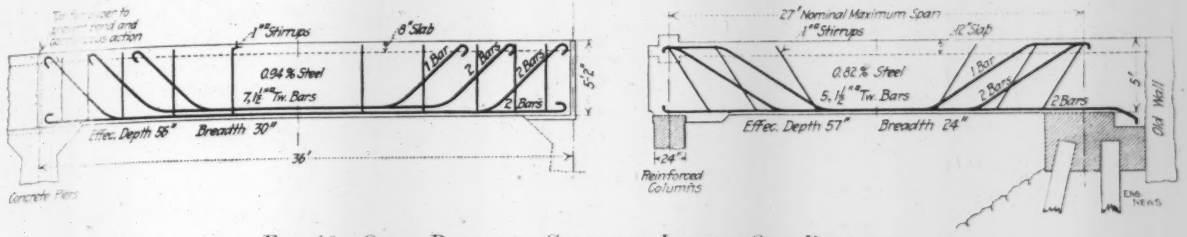


FIG. 10. QUAY BEAMS AT CEBU AND ILOILO. OLD PROJECT

and over supports. The depth of beam was then taken to utilize just this amount of steel in resisting horizontal tension at the center section. This gives a beam without stirrups and with graded flow of stress throughout.

The design is an extension of the bent-up bar idea, with the curves much longer and the bars relatively smaller and more numerous than usual. The curves are all circular arcs of the same radius and (with few exceptions) of the same length of arc, thus being very simple to specify. The radius was taken to make the bars pass the neutral axis at approximately 45°, and no attempt was made to turn them up to 90° at the top as would be their strictly correct position. Owing to the fact that these beams are large, and never by any chance subject to reverse moments, the opportunity for such a layout was good.

The beams shown in Fig. 10 are from existing structures, also from designs prepared by the writer. They are introduced here as illustrating types over which the beam of Fig. 9 is an improvement for practical as well as theoretical reasons. The main improvement is, of course, the more rational distribution of stress, approximating more nearly a condition of pure linear stress in each material, but there is also a considerable economy in the relative amounts of steel used:

AMOUNT OF STEEL IN THREE TYPES OF QUAY BEAM

(Cu.in. steel per cu.ft. beam per 1% center reinforcement)

Iloilo (old)	31.2
Cebu	21.4
Iloilo (new)	16.0

These figures represent the relative economy in steel *distribution*, since they are corrected to the same per cent. on the central section. Inasmuch as the three projects involve from 130 to 140 beams each, such a saving of steel was worth considering.

The new Iloilo project requires somewhat smaller bars than usual, making it possible to specify but one size of bar for the whole structure, slab and columns included. Work on this quay has not yet progressed beyond the substructure, so costs of setting up the steel are not yet in hand, but it is thought they will be less than usual. The rods are to be bent cold in a small roll operated by a hand crank. The smaller rods not only give a more graded distribution of stress, but for the same amount of steel they have a greater bonding surface. Four ¾-in. rods have the same sectional area as one 1½-in. rod, but they have twice the bonding surface.

The theory of reinforcing herein presented emphatically denies that stirrups take part in bearing the primary stresses of a beam. It does not deny that stirrups bear secondary stresses, or that the beam is stronger with than without them—it would be impossible to put steel into a beam in any position without making the beam the stronger for it. A stirrup is understood to be a vertical or sloping bar meeting or looping around the horizontal steel but not continuous with it. It is believed that the efficiency of the stirrup as an element of design has been over-estimated because of the prevalent habit of thought which looks upon horizontal stress as one thing and upon web stress as another thing. This habit is natural, since we must always begin our analysis of stress with the stresses on horizontal and vertical planes. But as a matter of fact the principal stresses are nowhere either horizontal or vertical within the mass of a beam. A glance at any plan of stress trajectories will show no mark or favor between horizontal and diagonal tension and will exhibit above all, continuity, curvature and gradual transition everywhere.

Beams may be designed, and well designed, on the basis of an embedded truss, but such design is not along the line of any unified theory of reinforced concrete, and an attempt to make it conform to such a theory only leads to confusion.

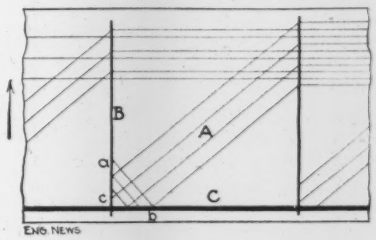


FIG. 11. HOWE-TRUSS ACTION OF REINFORCED-CONCRETE BEAM WITH VERTICAL STIRRUPS

The only explanation of vertical stirrups is their action as members of a Howe truss, as in Fig. 11. Without some truss-like connection at *c*, there can be no resolution of the push in *A* into a pull in *B* and *C*, without throwing the concrete into tension on the lines *ab*. Nothing can be clearer than that *B* and *C* should be connected by a continuous curve around the end of strut *A*, and when we consider that a reduction of the total cross-section of *C* toward the left is precisely what is wanted, such an arrangement is most convincing.

Stirrups fail to perform a primary function not because they are vertical, but because they are discontinuous with the horizontal steel. An excellent discussion of the action of stirrups, in the light of both practical tests and theory, is to be found in Chapter X of "Concrete-Steel Construction," by Emil Mörsch. But the discussion is a difficult one, since it is the demonstration of an "unideal" arrangement, and the conclusions must necessarily be of an unconvincing nature.

The Atlantic City Main Drainage Conduit

By T. Chalkley Hatton*

SYNOPSIS—The flatness of the site of Atlantic City and the slight elevation above salt water of the island on which the city is located presented a surface-drainage problem which was met by constructing a wide and shallow reinforced-concrete main drainage conduit lengthwise of the city. The conduit slopes each way from the middle to the outlets.

Atlantic City is located upon the eastern half of Absecon Island which is surrounded by the Atlantic Ocean on the south and the Beach Thorofare and Absecon Inlet on the east, north and west (Fig. 1). The Beach Thorofare is a very crooked stream with its western outlet into the ocean at Longport and its eastern outlet into Absecon Inlet, which is a bay connected with the ocean. The tide, which has a mean range of 4 ft., causes a current in both directions in the Thorofare which, at certain points near the city proper, is so narrow, for the volume of water passed through it daily, that the velocity of flow during ebb tide reaches a maximum of 3½ miles per hour.

The width of the island north and south runs from three-quarters of a mile at Albany Ave. to nearly four miles at a point about midway of the map, which shows that portion of the island known as Atlantic City proper. Chelsea district, which is now a part of the municipality, joins on the west.

The ground surface of Atlantic City ranges from 2½ to 9 ft. above mean high tide. The general elevation of the marsh land to the north of the city is about 6 in. above mean high tide. East and west the surface of the streets is on a dead level except that knuckles of about 6 in. are placed midway between the majority of the blocks, which are 400 ft. long in that direction. About 1000 ft. north of the ocean beach a ridge 9 ft. above mean high tide continues through the larger portion of the length of the city proper, and from this ridge to the original limits of the marsh, which is about at Baltic Ave., the surface gradually falls to an elevation of from 2½ to 3 ft. above mean high tide. North of Baltic Ave. the lands already occupied by streets and dwellings have been filled to an elevation of about 4 ft. above mean high tide.

For the purpose of carrying off the storm water from the street surfaces in the territory described, the city has, from time to time, built shallow wooden drains under the highways to the Thorofare, Absecon Inlet and to the surface of the marsh. As the surface of the marsh was raised from year to year to provide for street extensions and building sites the ends of these trenches were covered over and abandoned, thus affording no outlet for the storm water except as it might reach the surface of the marsh from the street gutters.

The situation becoming almost unendurable by reason of the flooding of Baltic Ave., which has the lowest ele-

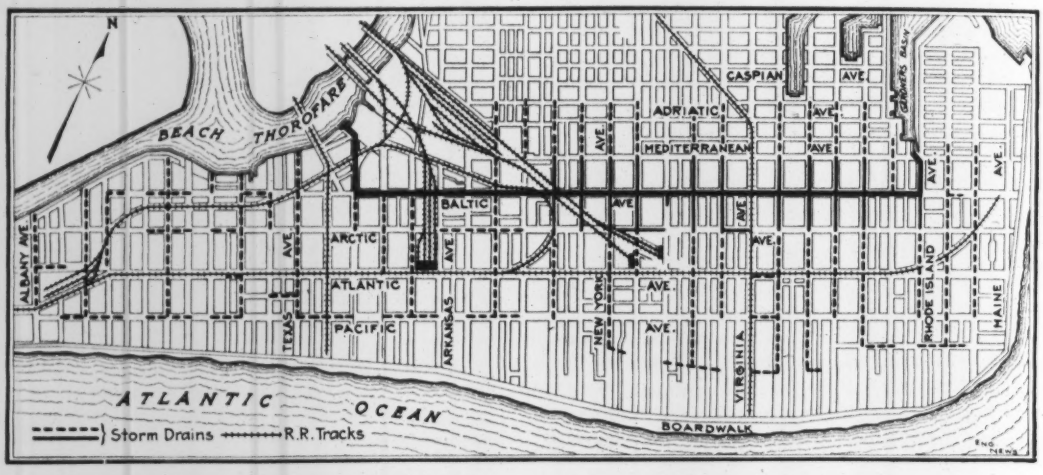


Fig. 1. Location of Main Drainage Conduit, Atlantic City, N. J.

vation of any street in the city running east and west, the city council employed E. Kuichling to consult with John W. Hackney, city engineer, and make recommendations for solving the drainage problem.

These gentlemen proposed the building of either an open or closed concrete conduit in Drexel Ave., which is an avenue running east and west midway between Mediterranean and Adriatic avenues. The conduit was to be a tidewater outfall with one end terminating at Gardner's Basin, an artificial spur of Absecon Inlet, and the other end at the Thorofare near the railway crossing (Fig. 1). It was designed to secure a regular discharge of its contents with every ebb and flood tide, and to have a uniform width of 9 ft. throughout so as to prevent deposits. The invert was to be built so as to provide for a depth of 6 ft. at high tide midway between the two ends and a fall of 3 ft. in either direction to the ends of the canal. If a closed conduit were built it was to be 11½ ft. wide, of horseshoe section.

Carrere & Hastings, of New York City, were subsequently engaged by the city as consulting architects to

*Consulting Engineer, Milwaukee, Wis.

the city engineer to prepare plans for a "city beautiful." They proposed an open drainage canal, at about the same location, but of a much greater width and with many features of embellishment designed to make it one of the attractive places of the resort. Owing to the great cost of carrying out the most excellently prepared plans of these architects the plans were unfortunately never adopted. In 1909 the writer was engaged to consult with the city engineer in the preparation of plans for completely underdraining the city, including the Chelsea district. He was instructed to design a covered main drainage conduit to be located in Baltic Ave., if such location was found feasible.

The design of the main drainage conduit was largely based upon the result of the studies made by Kuichling and Hackney in 1903, except that the writer used a greater rate of rainfall in determining the size of the conduit. The idea of having a tidewater conduit was adhered to as was the general elevation of the flow line.

After determining the volume of storm water which would reach the conduit at the various streets intersected, and assuming that the maximum runoff from the drainage area of 835 acres would have to be provided for during high tide, the problem was, first, to provide ample cross-section in the conduit above the level of mean high tide to carry the differing volumes of water discharged into it at the intersecting streets without unduly raising the hydraulic gradient of the conduit. An increase of elevation in the surface slope of the conduit meant a decrease in the hydraulic gradient of each lateral drain designed to carry the water to the conduit from the intersecting streets, and as this gradient, in many cases, was at best one foot to the thousand feet, every inch gained meant decreased size of lateral drains and increased velocity of flow therein.

Second, the depth of the invert of the conduit below the surface of Baltic Ave. must be such that the lateral drains in the intersecting streets could be discharged into it. These intersecting streets were well filled with water, gas, sewer and hot-water heating pipes, electrical conduits and house-service pipes at various depths, but too shallow to permit the lateral drains to be built above them. To build under them was the only practical location and this required an average elevation of flow line of lateral at the main conduit of —1, or 5 ft. below mean high tide.

With an assumed maximum rate of rainfall of 2.75 in. per hour, 60% running off within the hour in which it fell, with the conditions as above described and using the formula

$$Q = cr\sqrt[4]{a^3 s}$$

it was determined to use a conduit 10½ ft. wide, with a uniform cross-section of 15.75 sq.ft. above the level of mean high tide. It was estimated that the accumulated rise of the water in a conduit of the above width when the tide was high would be about 6 in.

The length of the conduit is about 9700 ft., and at midway the flow line is 6 ft. below mean high tide. The two ends are about 9 ft. below mean high tide, which gives a grade to the flow line of 0.6 ft. per 1000 in both directions from the middle distance of the conduit.

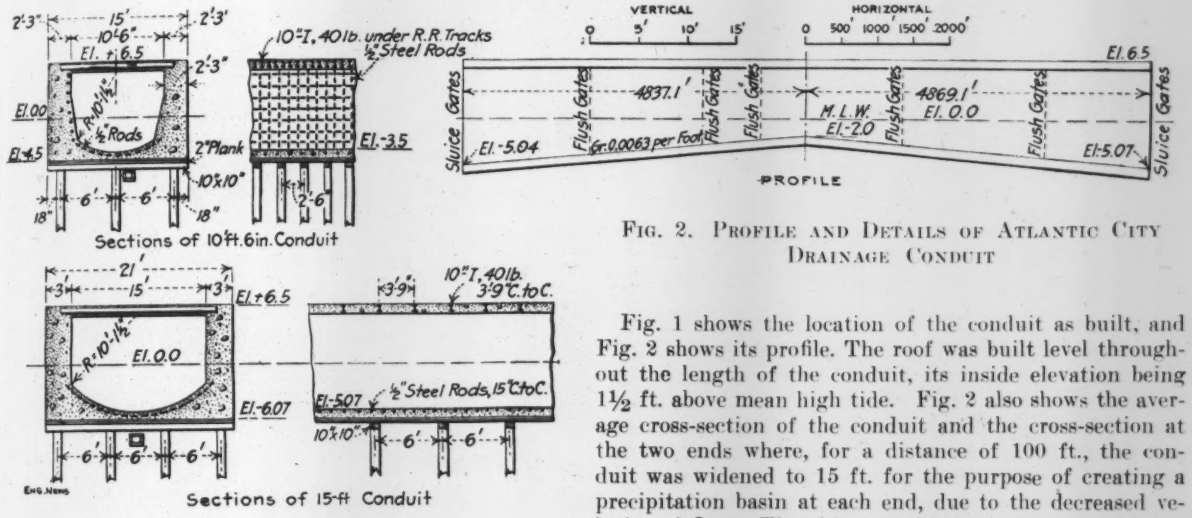


FIG. 2. PROFILE AND DETAILS OF ATLANTIC CITY DRAINAGE CONDUIT

Fig. 1 shows the location of the conduit as built, and Fig. 2 shows its profile. The roof was built level throughout the length of the conduit, its inside elevation being 1½ ft. above mean high tide. Fig. 2 also shows the average cross-section of the conduit and the cross-section at the two ends where, for a distance of 100 ft., the conduit was widened to 15 ft. for the purpose of creating a precipitation basin at each end, due to the decreased velocity of flow. The object of this basin was to reduce to a minimum the deposits of solids in Gardner's Basin and the Thorofare.

The invert of the conduit was reinforced throughout with ½-in. cold-twisted steel bars, spaced 15 in. c. to c. The side of the conduit next to the steam-railway track was reinforced with bars of the same spacing. Where the conduit bore the entire weight of track both sides were also reinforced in the same way.

Between blocks the roof was supported by 30-lb. steel I-beams, 3 ft. 9 in. c. to c. Under street intersections the I-beams were increased to 40 lb. and under railway tracks the I-beams were 40 lb. to the foot, spaced 10-in. centers. Between the I-beams the roof was formed of plain concrete, 12 in. thick throughout.

Special care was taken to get all steel well surrounded by concrete so as to nullify the corroding action of the salt water passing through the conduit.

The entire conduit was supported upon a pile and timber foundation. Under the normal section there were three piles to the bent, spaced 6 ft. c. to c., and the bents

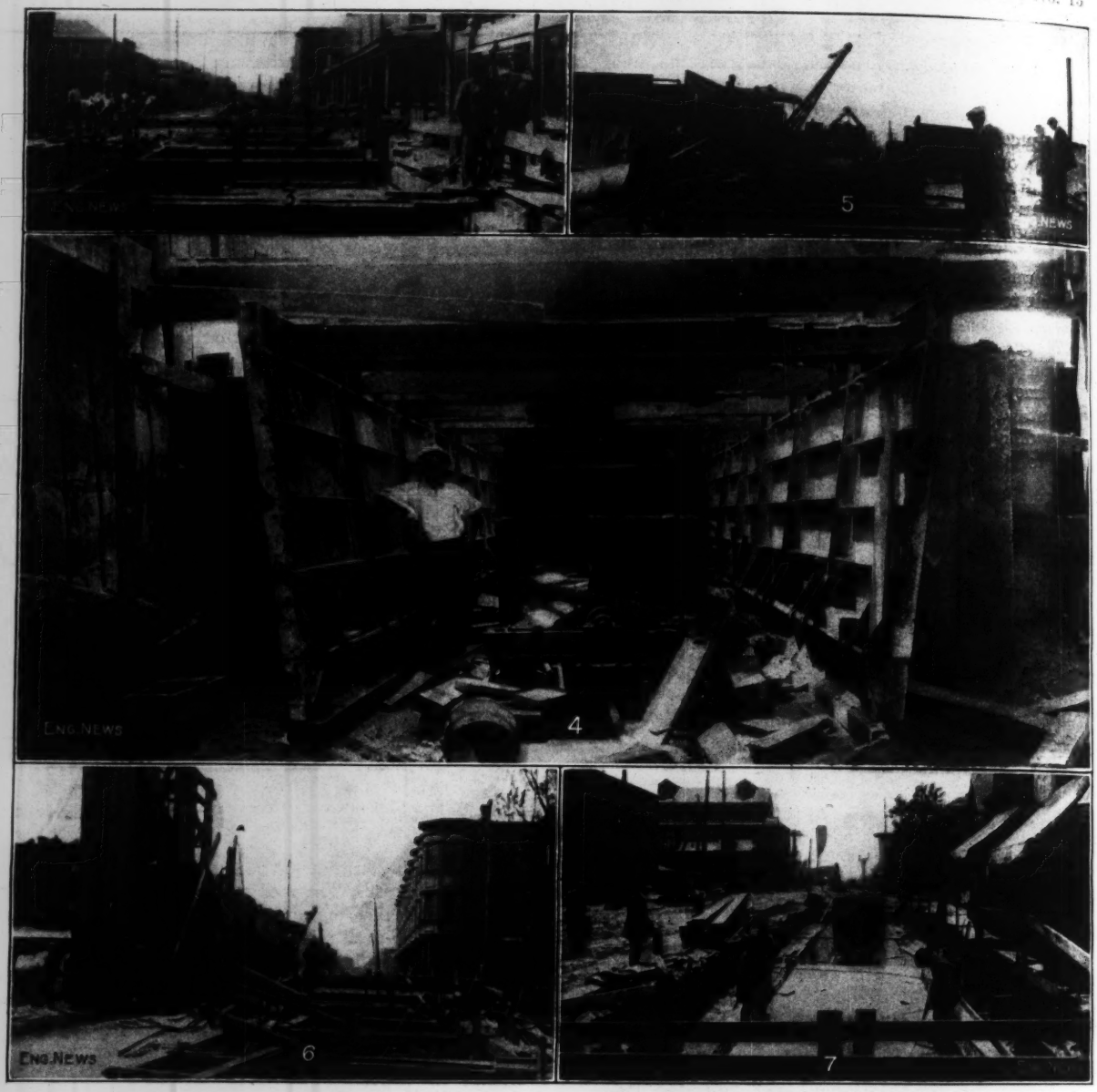


Fig. 3. Showing Proximity of Buildings to Trench.
Fig. 5. Locomotive Crane in Operation.
Fig. 6. Concrete Mixing Plant on Gondola Car.
Fig. 4. Invert and Two Side Walls Completed; Steel Forms Being Taken Down.
Fig. 7. Placing the Steel Roof Form.

FIGS. 3 TO 7. CONSTRUCTING THE SHALLOW MAIN SURFACE DRAINAGE CONDUIT, ATLANTIC CITY, N. J.

were also spaced 6 ft. c. to c. Under railroads the piles were doubled up. The caps were 10x10-in. yellow pine and the floor was laid with a double thickness of 2-in. yellow pine, with joints broken.

The piles were all jetted under water pressure to within 2 ft. of their ultimate depth. The last 2 ft. were driven with a steam hammer striking a blow equal to about 3800 lb. The hammer was never used until two or more hours after the jetting was completed, so as to give an opportunity for the sand disturbed under the pile by the water jet to refill the space thus made.

There were several difficult construction features not usual in such work and which were of more than passing interest. Upon Baltic Ave. for two-thirds of the length of the conduit there were two lines of railway belonging to the Reading system. One of these lines was removed but upon the other daily passenger and freight service had to be maintained. Numerous freight spurs crossed the line of the conduit, used for delivering freight to the several industrial houses along the street. Because both railway tracks had to be operated after the completion of the conduit, and it was undesirable to support them throughout by the conduit, the center line of the latter was placed under the curb line. This placed one-half the cross-section of the conduit under the sidewalk, bringing the outer line of the conduit within 3 ft. of the building line of the street.

Upon this building line there stood about 167 buildings of various character, built upon the sandy soil, with no foundations other than thin concrete walls extending

from 2 ft. to 3 ft. below the surface of the ground. All of the buildings had to be supported by piles jetted and driven along their fronts and with large timbers passing under the buildings and supported at their inner ends upon blocks, and all this foundation had to be built outside the lines of the conduit trench. Fig. 3 illustrates the proximity of the buildings to the trench. This supporting work was so well done by the contractors that no suit for damages to adjacent property was brought against them.

The entire excavation was through water-bearing sand, the active water horizon being about 4 ft. below the surface. All the underground water and also the water used in jetting the sheet piling and foundation piles was taken care of by a timber underdrain, built under the caps and carried to a pump well built at each alternate block, about 800 ft. apart. This well was supplied with a 6-in. or 8-in. centrifugal pump (sometimes both) which was continuously operated and the underdrain was kept open by surging a knotted rope through it several times a day.

Fig. 4 illustrates, among other things, how dry the work was kept by means of this underdrain. Here the invert and the two side walls are completed. The steel forms, which were used throughout the work, are being taken down to be set up in the forward section.

The entire excavation was handled by a locomotive crane operating a clam-shell bucket, the crane traveling upon the track of the Reading Railway system. All the surplus materials excavated were loaded into dump wagons and hauled to the marsh. The portion needed for refilling was handled by the crane traveling back and forth upon the work. Fig. 5 shows one of the cranes in operation.

The concrete was mixed by a batch mixer operated by a steam engine. The measuring bins, mixer, boiler, engine and cement house were mounted upon a long gondola car, as shown by Fig. 6. The stones and sand were hauled to the mixer and deposited upon a temporary wood floor placed upon the street surface. Each was shoveled into the elevators shown in Fig. 6. This being the only handling of the ingredients forming the concrete and of the concrete itself. From the mixer, chutes were used to carry the concrete where it was to be placed. The car was moved backward and forward upon the track, where needed, by the locomotive crane.

Several times during the day all of the machines occupying the Reading tracks had to be removed to the nearest available switch to permit the passage of the regular trains, but the contractors had the apparatus and organization so well arranged that these changes were made with a minimum loss of time.

Fig. 7 illustrates the two side walls and invert complete and the placing of the steel roof form. The building of each section of the conduit was carried on in three stages. After the pile and timber foundation was built the entire concrete invert between outside lines of conduit was built, and keyways left in the top of the concrete surface for making a water-tight joint with the side walls. The two side walls were then built to 2 ft. below the roof with vertical and horizontal keyways left in the surfaces. The third and last stage was the placing of the roof and the remainder of the side walls.

The steel roof forms were carried along the conduit upon the top of a specially constructed fabricated steel car operated upon a narrow-gage track built upon the invert of the conduit. This car is shown in Figs. 4 and 7.

The water- and gas-service pipes were built through the concrete roof of the conduit in thimbles composed of pipes of larger diameters than the service pipes so that the latter could be removed, when required, without breaking into the concrete. The service connections for the house sewers could not be provided for in this manner because the depth of such sewer pipes would have been too little to afford good service to the properties on the north side of the street.

To provide for the sewage from the north side properties a cast-iron pipe of different sizes and built at the required grades was built in the north wall of the conduit and was connected with the main sewers in the intersecting streets at four places. At these places the main sewers were carried under the conduit as inverted cast-iron siphons.

Inasmuch as the writer anticipated considerable deposit in the main conduit, due to the solids carried in the lateral drains, he gave considerable study to schemes for keeping the conduit clean other than by hand. It is

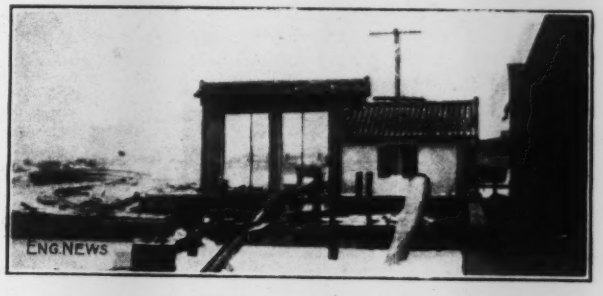


Fig. 8. Pump House and Gate Guides of End of Drainage Conduit, Atlantic City, N. J.

believed the scheme finally carried out is successful because up to date no labor has been required to keep this conduit and its lateral branches in satisfactory condition.

At each end of the conduit (Fig. 2) two wooden sluice gates were built, each 7½ ft. wide by 10 ft. 9 in. high, worked in timber guides built into the walls of the conduit and in a central column built between the walls. These gates were worked by a brass screw which was actuated by a 30-hp. motor built in a small house adjacent to the gates.

Within the 15-ft. wide section of the conduit, designed as a precipitation tank, a pump sump was built and a 12-in. centrifugal pump built in the house above alluded to was connected by a 12-in. suction to this sump. The pump is operated by the same motor which operates the gates. Fig. 8 shows the pump house and gate guides.

At intervals of about 1600 ft., gates were built into the conduit. These gates were built in the form of two barn doors hung on a rack built in the roof of the conduit, the bottom of the doors working in a slot built into the invert. Recesses for the doors to work in when being opened were built on each side of the conduit. The doors are operated by hand power, a valve key being used upon the surface of the street. This key is connected to reduction gears so that two men can open and close the gates when the greatest load is against them.

The object of the gates was to make it possible for each section of the conduit to be cleaned by flushing.

During high tide one section can be closed, holding the water in it until low tide, when there will be about 485,000 gal. of water under a 4-ft. head to flush a section of conduit about 1600 ft. long. Each section can be flushed at each high tide until the whole conduit is cleaned. The two end gates were built not only for flushing but also for making examinations and repairs possible. When these two gates are closed at low tide the two pumps can clear the conduit of water in five hours and keep it free of water, except in the event of a storm.

The total length of the conduit is 9706 ft. Its cost, exclusive of engineering supervision, was $669,812. The cost of engineering and supervision was $46,887.

The contract price for the normal section of conduit 10½ ft. wide was $49.50. The cost of pile and timber foundation and underdrain was $14 additional. Where the conduit had to support railroad tracks the cost was raised to $97.12 per ft., due to the increased amount of steel beams, reinforcing bars and pile foundation.

Each of the sluice gates, pump houses and equipment at either end of the conduit cost $11,575. Each of the intermediate flushing gates cost $3300. Timber foundations cost $40 per 1000 feet b.m. Piles in place, measured after being sawed off for caps, cost 40c. per ft. The length of the piles averaged 8 ft., except under railway tracks.

Although many unexpected underground [illegible] surface obstacles were encountered and the entire wo[illegible]s of a difficult character the extras paid for under t[illegible]rms of the contract amounted to less than 1% of th[illegible]al contract. At no time was railway, vehicular or [illegible] travel seriously interfered with. Every person livi[illegible] or carrying on business upon the street in which t[illegible] conduit was built was given free ingress and egress t[illegible] property. But one accident occurred, resulting i[illegible] death of a foreman by being electrocuted from a b[illegible]n wire carrying a high-potential electric current. A[illegible]rvices such as gas, electric lighting, telegraph, teleph[illegible] sewer and water, were maintained throughout the w[illegible]k with but little interruption.

The contractors for the work were the W. [illegible] Root Construction Co., of New York, who maintained an up-to-date and successful organization throughout and completed the work very satisfactorily to the engineers. The engineering board having charge of the construction consisted of E. D. Rightmire, city engineer, John H. Decker, of Atlantic City, and T. Chalkley Hatton, of Wilmington, Del. The resident engineer in active charge of construction was James L. Ferebee, who was Mr. Hatton's principal assistant. The work was begun in March, 1911, and completed in the fall of 1912.

Tests of Some Joints Used in Heavy Timber Framing

[Second Half; For First Half See Engineering News, Mar. 19, 1914, *pp.* 593-598]

By H. D. Dewell*

SYNOPSIS—Tests of lagscrew connections, bolted joints, and bearing capacity of washers. Bolted connections need not be figured for bending in bolts. Washers are ordinarily too small for Douglas fir. The framing of the Panama-Pacific exposition buildings involves all these types of connection in addition to the pin-keyed joint covered in our preceding issue. Summary.

Tests of Lagscrewed Joints

This series of tests was made to determine the resistance of lagscrews to lateral forces, as when used in fastening the members of a built-up timber column together by means of wooden lacing bars. The lagscrews here bear across the fibers of the wood of the main timber, and against the ends of the fibers of the 2-in. plates.

The only data at all applicable to this type of joint are given in Kidder's "Architects' and Builders' Pocket Book," where the resistance of lagscrews used in fastening a thin steel plate to the chords of a wooden truss is given as 2100 lb. for a ¾x4½-in. screw.

Fig. 10 shows the detail of the joint tested. Table IV gives the results of the test.

The slip at the load giving the first crack was from ⅛ in. to $\frac{3}{16}$ in., and the final slip about ½ in. to ¾ in. The failure in four of the joints was due to the screws splitting the side of the main member at a season crack, the main timbers in these joints being badly season-checked.

*Chief Structural Engineer, Panama-Pacific International Exposition, San Francisco, Calif.

TABLE IV. TESTS OF LAGSCREWED JOINTS (FIG. 10)

(Loads in pounds)

Joint	First slip		Ultimate	
	Total	Per screw	Total	Per screw
a (6 screws)	11,000	1833	23,000	3833
b (6 screws)	16,000	2667	30,000	5000
c (8 screws)	21,000	2625	30,000	3750
d (6 screws)	16,000	2667	31,000	5167
e (8 screws)	20,000	2500	30,000	3750
f (8 screws)	18,000	2250	29,000	3625
Average value of one screw.....		2423		4187

Note—The failure in joints (a), (c), (e) and (f) was due to the screws splitting the side of the main member. In joints (b) and (d) the attached piece was sheared by the screws.

Tests of Bolted Joints

In conjunction with the design of the timber bleachers for the football field of the University of California, in 1904, tests on bolted joints were made by E. E. Adams. The results* should be more widely known.

The joints were made of 2x10-in. planks, bolted with ½-in. and ¾-in. bolts with standard cast-iron washer. Three different bolt arrangements were used. Fig. 11 gives the details. The test results are given in Table V.

TABLE V. TESTS OF BOLTED JOINTS (ADAMS, 1904)

Test No.		Bolts	Breaking load, lb.
1	2 bolts	½ in.	42,350
2	2 bolts	¾ in.	35,000
3	2 bolts	½ in.	27,130
4	2 bolts	¾ in.	26,960
5	4 bolts, square	¾ in.	61,520
6	4 bolts, staggered	¾ in.	57,250
7	4 bolts, staggered	¾ in.	70,500
8	4 bolts, square	¾ in.	50,250

*Reported in "California Journal of Technology," September, 1904.

Mr. Adams, in his report of the tests says:

> The joints were tested to failure. In every case the first failure occurred by compression of the wood under the washers. The ½-in. bolts in each case finally failed by tension, while with the ¾-in. bolts the wood failed. * * * The failure occurs in such a complicated form, by tension and bending together with shear on the bolts, compression of the wood under the washers, and also against the bolts, and shear of the wood, that a theoretical computation is of little value. A series of tests on full-sized joints is the only way to obtain reliable information.

Unfortunately, no mention is made of the load at which the first slip occurred, the amount of such slip, nor the slip at the ultimate load. From the tests on lag-screw joints, the writer judges that the first slip occurred at a load approximately 0.4 to 0.5 the ultimate load.

There is one point in connection with these tests which is worthy of consideration. It has always seemed to the writer that the bending of the bolts in such joints as these (and especially in joints where metal plates are bolted to timber) is far less than is ordinarily assumed. The amount of the bending moment in one bolt, as usually computed (see Jacoby's "Structural Details," Art. 24; Howe's "Design of Simple Roof Trusses in Wood and Steel," Art. 59; and the "American Civil Engineer's Handbook," Sec. 7, Art. 34) is ½ *Pa*, where *P* is the total load on the joint and *a* is the distance between lines of pull, in this case 2 in. The fiber-stress to be used in design for such a case would be from 15,000 to 22,500 lb. per sq.in. By this formula the *apparent fiber-stress* in the bolts due to bending at the time of failure, also the *apparent bearing stress* against the ends of the fiber at the ultimate load, has been computed for the test joints, and the results are given in Table VI, together with the safety factor that design stresses of 16,000 and 1600 lb. per sq.in. would furnish.

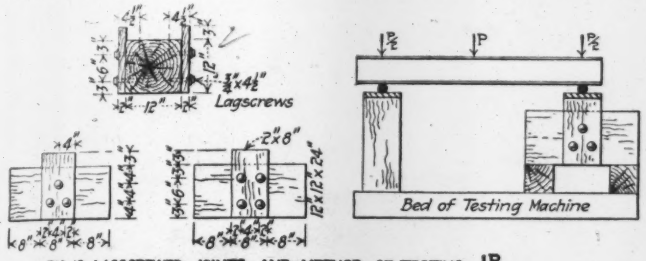


FIG. 10 LAGSCREWED JOINTS AND METHOD OF TESTING

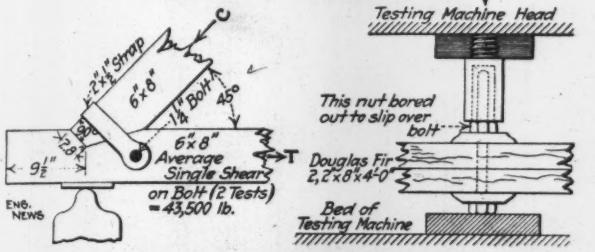


FIG. 12 TRUSS JOINT (M.I.T. TEST 1897)

FIG. 13 METHOD OF TESTING WASHERS (BIXBY, 1904)

Assuming that the yield-point of the joint is one-half the ultimate load, it is seen that the safety factor on the yield-point against failure by bending ranges from 17 to 35, with an average value of 24, while the average safety factor on the ultimate strength against crushing of the wood by end bearing is about 4. It would seem reasonable to say, therefore, that bending was not the initial cause of failure. The writer believes that in joints of this kind where a metal or a wooden plate is bolted to a timber, and where the thickness of such plate is not over 2 in., the bolt may be designed for shear and bearing, both of timber and metal, and the bending in the bolt neglected. This condition of no bending assumes a *driving fit of bolts*, or a hole of no greater diameter than that of the bolt.

Further justification of this belief is given by the tests on end connections of trusses, made in the engineering laboratories of the Massachusetts Institute of Technology, in 1897, and reported and discussed by F. E. Kidder in *The Engineering Record* of Nov. 17, 1900. In the tests of two joints (shown in Fig. 12), the bolts were subjected to an average apparent bending moment of 76,000 lb.-in., computed as above, or to an average stress of 400,000 lb. per sq.in. on the extreme fiber. The author of the article notes that after failure of the joint the bolts did not appear to be injured.

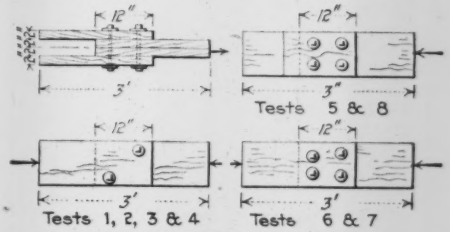


FIG. 11 TESTS OF BOLTED JOINTS (ADAMS' TESTS, 1904)

TABLE VI. APPARENT STRESSES IN BOLTED JOINTS AT FAILURE, AND SAFETY FACTORS OBTAINED WHEN DESIGN IS BASED ON 16,000 AND 1600 LB. PER SQ.IN.

Test No.	Total load, lb.	Bolts	Bending stress in bolt, lb. per sq.in.	Factor of safety for 16,000	Bearing stress, lb. per sq.in.	Factor of safety for 1600
1	42,350	2¾	512,000	32	7058	4.4
2	35,000	2¾	424,000	26.5	5833	3.63
3	27,130	2¾	1,110,000	69.5	6783	4.24
4	2[illegible],960	2¾	1,100,000	68.6	6740	4.27
5	6[illegible],520	4¾	373,000	23.3	5127	3.21
6	57,250	4¾	1,170,000	73.0	7157	4.48
7	70,500	4¾	426,000	26.7	5875	3.67
8	50,250	4¾	1,025,000	64.0	6282	3.92
			Average	48.0		

Section modulus, ¾-in. bolt 0.0413; ⅝-in. bolt 0.01225
Bending moment for all bolts, ¼ load × 2 in.

Tests of Washers in Cross-Grain Bearing on Douglas Fir

This series of tests, as noted before, was made by F. L. Bixby, in 1904, as a thesis for graduation in the College of Civil Engineering of the University of California. It was the result of the tests of Mr. Adams, in which tests the first indication of failure was the crushing of the wood under the bolts, which suggested that the standard cast-iron washer is altogether too small to develop the strength of the bolt when used on Douglas fir or similar woods. The object of his investigation was to find what percentage of the strength of the bolt at its elastic limit the standard cast-iron washer of the trade would develop, then to design a washer of such proportions that the elastic limit of the wood in bearing across the fibers would be reached at the elastic limit of the bolt. The investigation was made in the following order.

The strength of a rod in direct tension was found for three conditions, by six tests on each condition for each of three sizes of bolt, ¾-in., ⅝-in. and ½-in., or 54 tests in all:

Method 1—The rod was threaded on one end, and a nut screwed on. The load necessary to strip the threads was found.

Method 2—The other end of the rod was threaded, and, the bolt and nut being again placed in the testing machine, load applied by turning up the nut with a wrench, to failure.

Method 3—The rods were tested in tension to failure.

The average efficiency of the bolt by Methods 1 and 2, compared with Method 3, was found to be 71% and 61½%, respectively.

Next, two pieces of 2x8-in. planking 4 ft. long were tacked together, holes bored for bolts, and bolted up with standard cast-iron washers. The test was then made as sketched in Fig. 13. The nut at the top was bored out so

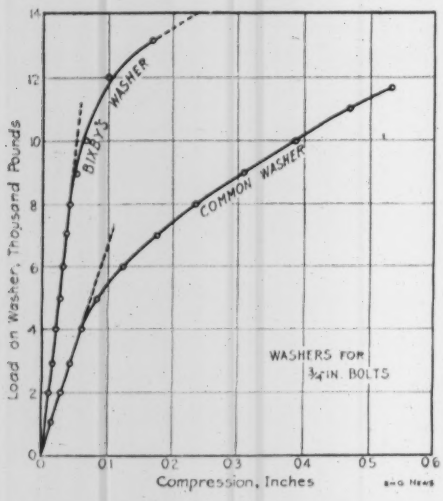


FIG. 14. LOAD-COMPRESSION CURVES OF CAST-IRON WASHERS ON DOUGLAS FIR (BIXBY, 1904)

that it would slip over the bolt. The test was carried to the elastic limit of the wood, determined by deflectometer. It was found that the ultimate load reached developed only about 50% of the strength of the bolt. Eight tests were made for each size of bolt.

The results are condensed into the figures of Table VII, which gives also the efficiency of the washer on the basis of thread-stripping strength (Method 1), one-half of the ultimate thread-stripping strength of the bolt being taken to represent the elastic limit of the bolt. If the washers were rated on the basis of thread strength as found by Method 2, their efficiencies would come out about one-sixth higher. On the other hand, if rated on the basis of the tensile strength of the unthreaded bolt (Method 3), the washer efficiencies would be one-third lower.

The load-compression curve for one of the ¾-in. washer tests is given in Fig. 14. The same diagram gives the curve for a ¾-in. washer of larger diameter, designed by Mr. Bixby to develop the full bolt value when used on Douglas fir.

These specially designed washers were given the following diameters: For ¾-in. bolt, 4.38 in.; for ⅝-in. bolt, 3.44 in.; for ½-in. bolt, 2.96 in. Tests were made on these washers as for the standard washers. The results, rated on one-half the thread-stripping strength as before, showed average washer efficiencies of 86% to 91% (as compared with the 29% to 39% shown by the ordinary washers, Table VII).

TABLE VII. EFFICIENCIES OF STANDARD CAST-IRON WASHERS IN CROSS-FIBER BEARING ON DOUGLAS FIR

(8 tests were made on each size)

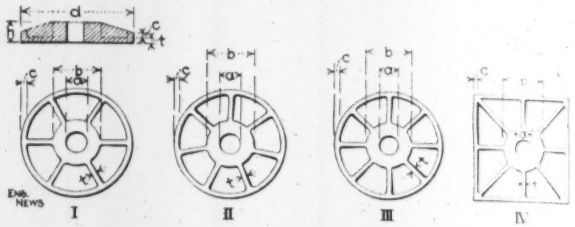
Bolt	Load at el. lim. of wood	Av. ultimate bolt strength (thread stripping, method 1)
¾-in.	3000-4200 av. 3580	18,600*
⅝-in.	2000-2500 av. 2290	12,400*
½-in.	1250-1500 av. 1290	8,900*

*One-half of these figures is taken as the value of the "elastic" bolt. Washer load at elastic limit divided by this value gives efficiency column.

TESTS ON SPECIAL WASHERS FOR EXPOSITION

Since Bixby's tests showed that the ordinary cast-iron or malleable washers are entirely too small for cross-fiber bearing across the fiber of Douglas fir, it was decided to use a special cast-iron washer in the framing of the exposition buildings. Hence the washer as shown in detail in Table VIII were designed and are being used (with modifications noted below).

TABLE VIII—PANAMA-PACIFIC CAST-IRON WASHERS



(All dimensions in inches)

Size bolt	Size of upset	a	b	c	d	h	t	Type	Weight, lb
¾	not upset	¾	1⅝	¼	3½	¾	¼	I	0.562
¾	not upset	¾	1½	5/16	4	1⅛	5/16	I	1.098
¾	not upset	1	2¼	5/16	4½	1¼	5/16	I	1.795
¾	1	1¼	2¼	⅜	5	1¼	⅜	I	2.785
¾	1¼	1¼	2¼	⅜	5½	1½	⅜	I	3.280
¾	1¼	1¼	3	⅜	6½	1½	⅜	II	5.298
1	1¼	1¼	3½	5/16	7	1½	5/16	II	6.343
1¼	1¼	1¼	3¾	⅜	7½	1½	⅜	II	9.042
1¼	1¼	1¼	3¾	⅜	8½	1½	⅜	II	11.300
1¼	1¼	1¼	4	⅜	9½	2¼	⅜	II	13.592
1⅜	1¼	2	4½	5/16	10	2¼	5/16	III	18.657
1½	2	2½	4½	⅜	10½	2½	⅜	III	20.393
1½	2½	2½	4½	⅜	11½	2½	⅜	III	25.988
1½	2½	2½	5½	⅜	12½	2½	⅜	III	30.623
1½	2½	2½	5½	⅜	11½	4½	⅜	IV	48.234
2	2½	2½	5½	⅜	12	5½	⅜	IV	69.317

Note.—Provide ¼" fillets on all washers.

These washers are given sufficient area of base for a cross-bearing stress on the timber of 350 lb. per sq.in. when the stress in the rod is 16,000 lb. per sq.in. The washers for the ¾-in. bolt are practically the same as the standard used by the Atchison, Topeka & Santa Fé Ry. (see report of Am. Railway Engineering Assn.). Reference was also had to the details and tests of cast-iron washers as given in Jacoby's "Structural Framing." Using practically the same dimensions for the largest washers as described in this reference, as to height, number and thickness of ribs, and base plate, the dimensions of the intermediate sizes were determined approximately by proportion, and then checked by computation for strength.

In the design, the assumption was made that each rib with its section of baseplate acts as a cantilever T-beam, supporting a uniform load over its base. The maximum fiber stress in bending (at the edge of the spool) was taken at 4000 lb. per sq.in.

It was believed that the washers for the smaller bolts were less efficient than those of the larger bolts, as the effects of internal stresses and flaws would be more marked in the case of small washers. Tests were there-

fore made on a number of the washers as delivered to the building. The washers tested were from two different foundries; in the table of results the sets are designated as *A* and *B* washers.

The first washer tested was a ¾-in. *A*, and was placed in the testing machine fitted with a short length of bolt with only the nut bearing against the head of the testing machine, and the washer bearing across the fibers of a short block of Douglas fir, the bolt fitting into a hole bored in the wood. A total load of 23,000 lb. was sustained without fracturing the washer, but with the washer sinking into the wood about ½ in.

The other washers were broken by making them bear against the ends of the fibers of the block of Douglas fir, the head of the testing machine bearing directly upon the washer. It should be noted that the ends of the wooden block were not exactly parallel, so that the machine head bore eccentrically on the washer, producing bending stress in the cast-iron. As this condition is often met in practice, due to the bolts not being exactly normal to the timber, the result of the test may be taken as typifying the strength of such washers under the most adverse conditions to be met with in actual construction. Table IX gives the results of the test.

TABLE IX. FAILURE TESTS OF EXPOSITION WASHERS

Size, in.	Ultimate load, lb.	Remarks
	Washers from foundry "A"	
¾	20,000	Failure at edge of head
¾	28,000	Failure through head
¾	16,000	Failure through ribs; flaws
¾	17,000	Failure through ribs; flaws
¾	33,000	Failure through head
¾	23,500	Failure at edge of head
1	23,000	Failure through head
	Washers from foundry "B"	
¾	18,000	
¾	20,500	Failure through ribs near rim
¾	7,500	Failure through center of hole
¾	9,500	Failure through head
¾	9,500	Failure through head
¾	16,000	Failure at edge of head
¾	14,000	Failure at edge of head
1	25,600	Failure through head
1	17,000	Flaws
1	23,000	Small flaw
1	26,000	Small flaw
1	23,000	Small flaw

Due to the rather poor showing of the B-foundry washers for ¾-in. and ⅞-in. bolts not upset, the dimensions of these sizes were revised as follows:

¾-in.: Height increased from $\frac{13}{16}$ in. to 1 in.
Thickness *t* increased from $\frac{3}{16}$ in. to ¼ in.

⅞-in.: Thickness *t* increased from $\frac{3}{16}$ in. to ¼ in.

General Conclusions

The following notes may be made in conclusion:

Pin-Keyed Joints

White-Oak and Gas-Pipe Pins—The low resistances developed in the tests make the further consideration of oak (at least the oak procurable in this vicinity) unnecessary. Gas-pipe is also shown conclusively to be worthless as a material to be used in pins.

Steel and Ohia Pins—While the number of the tests made is not sufficient to prove absolutely the relative efficiencies of the different materials used for pins in the joints, the results show that the extra-heavy wrought-steel pipe is practically as efficient as the solid metal, but that both give lower resistance than the Ohia pins. The results as to tension in the bolts are unsatisfactory. The stress in each of the three bolts should have been measured; the ends should have been cut truly at right angles to the axis of the bolt, and tests of the joint using larger washers should have been made. However, the impression gained in watching the joints under load, both by the writer and others, was that the joint was proportioned about right.

Defective Ohia Pins—At the working load, these joints had appreciably no slip, and as it may be expected that no joint in practice will be as poor as these, the use of 800 lb. per lineal inch of Ohia pin is considered amply safe.

Australian Hickory Pins—While the ultimate strength of the joints was about the same as that of the joint with defective Ohia pins, the yield-point was lower. The wood appeared to be softer than Ohia, and as the pins were samples and therefore probably better than could be expected for the average pin delivered in quantities, this material was rejected as unsuitable for the pins.

Lagscrewed and Bolted Joints

Lagscrewed Joints—As has been noted in the description of this series, the failure, both ultimate and at first marked distortion, was due primarily to the main timber splitting at a season check. The part of the lagscrew embedded in the main timber exerted pressure across the grain. In connections of this kind, it is believed that the resistance of the screw is appreciably the same whether it bears *against* or *across* the grain of the main timber. Similar results have been shown by tests upon nails. In the case of a metal plate lagscrewed to timber, it is believed that the strength would be determined by the strength of the screw in shear, or the plate in bearing.

Bolted Joints—In bolted joints the bending in the bolt is usually given too much consideration. The number of tests is too small for definite conclusions, yet the results are interesting and may be very useful when supplemented by further tests.

Washer Tests—Bixby's tests showed conclusively the fallacy of using the ordinary washers with bolts or rods in which considerable tension exists. More money may be economically expended in increasing the bearing resistance of the washers.

Exposition Washers—The washers from foundry A were uniformly weaker than those from foundry B. There is a great variation in the strength of different washers of the same size, but possibly no more than could be expected for a material as uncertain in its qualities as cast-iron.

The ¾-in and ⅞-in. washers appear to be less efficient than those of larger diameter. For this reason their metal thickness was increased to ¼ in. in later work.

For permanent work the writer would recommend that washers be given an area to provide bearing across the fibers of Douglas fir at a stress of 285 lb. per sq.in. (one-half the elastic limit) when the stress in the bolt is 16,000 lb. per sq.in., and that no thickness of metal be less than ¼ in.

A Street-Naming System which has been suggested denominates all main east and west thoroughfares as "streets" and minor ones as "places"; all main north and south thoroughfares as "avenues," and minor ones as "courts," and all diagonal thoroughfares as "ways." All "streets" to the north of a central east and west base would have even numbers, and all those south of that line, odd numbers. In the same way, all "avenues" east of a north and south base line would have even numbers and those south of that line odd numbers. Diagonal "ways" may be numbered, or given a name indicating the direction from the center of the city. The house numbering would be on the decimal system, 100 to each block (disregarding intervening "places" or "courts"), with the even numbers on the north and east sides. This method is proposed by H. E. Bartlett, of Chicago.

Two Years' Experience with the Appointments Board of the Institution of Civil Engineers

The establishment of the Appointments Board of the British Institution of Civil Engineers was commented upon in our editorial columns of Mar. 14, 1912. It was then noted that the evident intent was to aid in filling minor positions in engineering only. The report of the Board for the first two years, recently issued, is not encouraging to those who would like to see the work carried far enough to be of genuine benefit to all members of the profession.

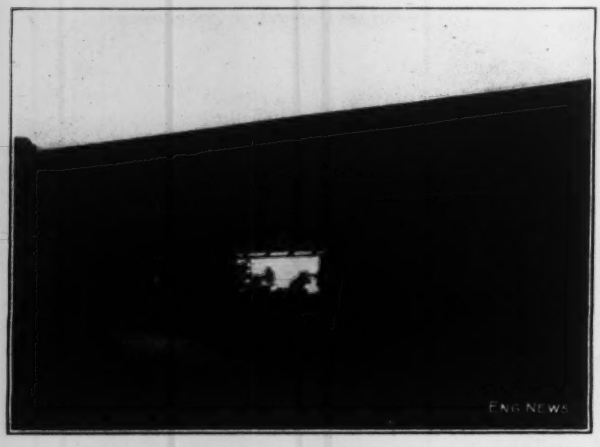


FIG. 1. AN EAST INDIAN RAILWAY BRIDGE, IN SERVICE NEARLY 30 YEARS

As a beginning, however, on a line of useful development, such as has been strongly urged from time to time by progressive members of the American Society of Civil Engineers, the work of the Institution's Appointments Board is of considerable interest, as well as for the side light it gives of engineering employment conditions in England. This work of the Institution is done entirely by correspondence from an office established for that purpose; and the following details in regard to it are taken from the report above referred to:

Applicants for employment register particulars of their education, training, experience, and intentions, upon prescribed forms, which are duly classified, and to which reference is made in connection with applications from employers for assistants; the names of those who appear to be suitable for any given post being communicated to such employers, while a synopsis of the particulars of the post is simultaneously transmitted to the persons whose names are suggested, with an intimation to them to make direct application for the position.

The following is a statement of the business transacted:

	From February, 1912, to Dec. 31, 1912	For the year ended Dec. 31, 1913
Registrations	235	164
Inquiries from employers for assistants	110	112
Suggestions made	463 (representing 154 and 176 individuals respectively)	536
Inquiries for tuition	16	12
Suggestions made	46	37

In addition to the foregoing, 33 suggestions have been made in response to inquiries for particular engineering services not involving the appointment of assistants, and a considerable number of suggestions in regard to pupilage.

It is difficult to state with any certainty the number of assistants who have secured appointments as the result of the Board's action, as that depends upon information voluntarily supplied by those who obtain posts; and in many cases positions which are the subject of inquiry through the Board are also advertised or made known otherwise and, when filled, it is uncertain to what extent the Board's suggestion or recommendation may have influenced the result. The number of appointments definitely known to have been secured by the Board's action in the period referred to is 54, and the number of engagements for tuition 13.

This can scarcely be considered, from a business point of view, as a satisfactory result of the considerable labor involved, having regard especially to the complete system of registration, reference and bookkeeping, which is required by the regulations of the Public Control Department of the London County Council for any such an undertaking. To such extent, however, as success has attended the efforts made, they may be regarded as in a useful direction; and it is hoped that as the organization becomes better known, its operations may be extended, especially in the way of helping young men to arrange for pupilage or other practical engineering training—a matter which is known to present considerable difficulty to many of those who are about to take the first step in the engineering profession.

The undertaking has been so far self-supporting, a condition which must be attributed in a large measure to the executive work having been done voluntarily and gratuitously; and it has not been necessary to make any call upon the guarantee which was generously offered by the Council when the Board was formed. The fees charged are on a very moderate scale, 60c. for registration, which action implies, of course, no responsibility on the part of the Board, $5 on securing a permanent appointment, and $2.50 an appointment of a temporary kind. No fees are charged to employers in connection with the recommendations made to them.

A Remarkable Railway Bridge

The railway bridge shown in the photograph herewith is reported to have carried the double-track line of the East Indian Railway over Ferry Fund Road, Naihati, since 1886, or for nearly 30 years. Its construction is credited to Bradford Leslie. The photograph and information are from the *Indian and Eastern Engineer*, of

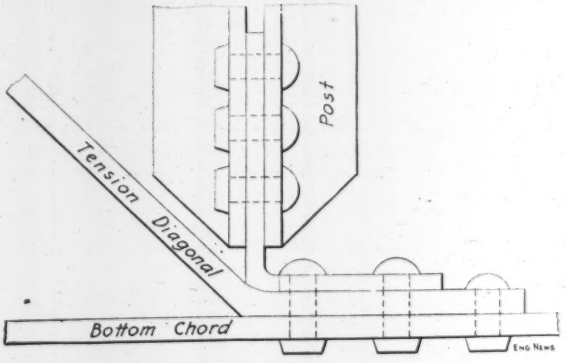


FIG. 2. CONNECTION OF WEB-MEMBERS TO CHORD, FERRY FUND ROAD BRIDGE

January, 1914, where it is stated that the bridge shows no signs of deterioration.

The joint between web members and chord members is of the arrangement sketched in Fig. 2. It is especially praised by the editor of the *Indian and Eastern Engineer*, largely because the full area of the tension diagonal is claimed to be effective, since the rivet holes deduct area only from the horizontal portion, and this does not carry full stress. The joint is dignified by the special name of "knuckle joint," and the bridge is called a bridge of "knuckle-girder" type. This type is further praised for exposing minimum area to wind pressure. Incidentally, the chords of this bridge are made of scrap

rail; in fact, the text states that the bridge is *entirely* made of iron scrap rail, but both sketch and photograph seem to indicate that the web members are of other section.

A New Design of 1500-Volt Direct-Current Locomotive; Piedmont & Northern Ry. Lines*

Six 53½-ton 1500-volt direct-current electric locomotives of interesting design have been placed in service on the Greenville, Spartanburg and Anderson Division of the Piedmont & Northern Lines, Charlotte, N. C. These lines have a heavy freight traffic, transporting quantities of cotton from collecting points to mills and fabrics from the mills to connecting railways. All the weight of the locomotive is on the eight drivers. There are four 200-hp. 750-volt motors (one geared to each axle) two electrically connected in series. The locomotive will develop a maximum tractive effort of 17,500 lb. and a speed of 21 miles per hour, handling trains of up to 1000 tons gross weight.

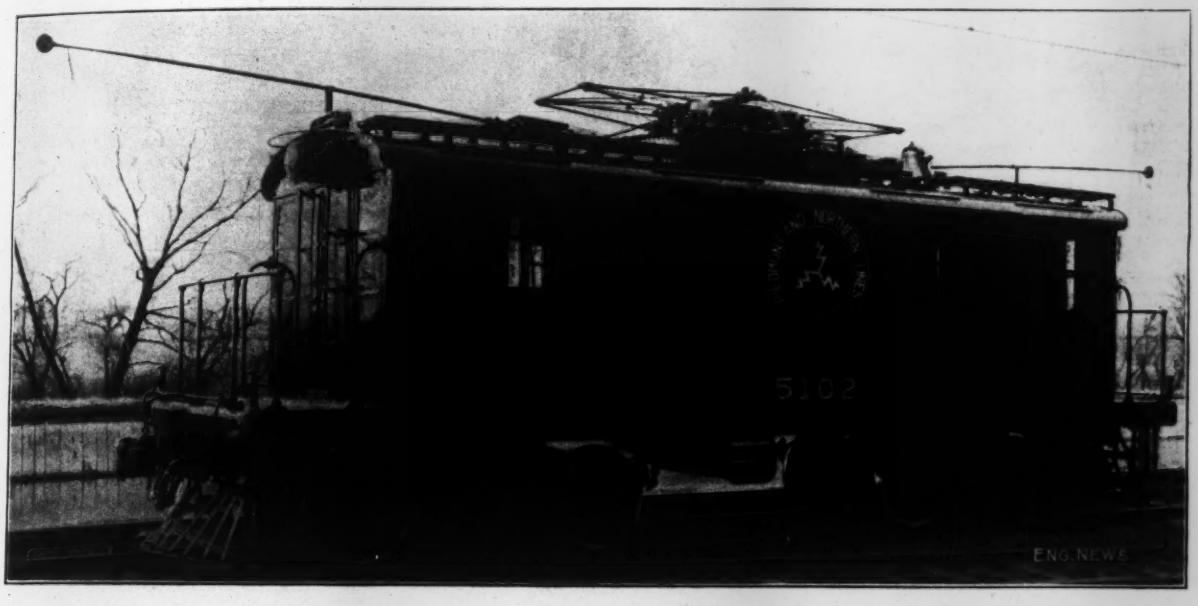


FIG. 1. DIRECT-CURRENT LOCOMOTIVE FOR THE GREENVILLE, SPARTANBURG & ANDERSON RY.

The underframe of the locomotive consists of four 10-in. steel channels extending the entire length of the platform and tied together by heavy end-frame box-girder castings and bolster plates, each channel being riveted to the webs of the end-frame castings and to the top and bottom bolster plates. The bolsters are built up of 18x1-in. plates, the top bolsters being carried clear across the platform and riveted to all four longitudinal sills. The two center channels are inclosed throughout with steel plates riveted to the under sills and carry the center-pin castings, which are bolted to them. The closed space thus formed between the center sills serves as a reservoir for distributing air from the blowers to the motors. Openings in the floor of this reservoir admit air from it through flexible intake pipes into the back end of each motor.

The drawhead castings are bolted to the center sills, which in turn are riveted to the end frames. The draft gearing consists of M. C. B. No. 3 couplers with 5x7-in. shank and standard yoke, twin springs and follower plates. The whole platform is floored and braced by heavy steel plates running the width of the locomotive and riveted to the longitudinal sills. In the cab this is covered with wood flooring. The ballast required to bring the locomotive up to desired weight consists of steel bars running the whole length of the platform, notched over the bolster plates and bolted to the longitudinal sills. Pilots with switchman's steps are bolted to the end frames and braced to the side sills.

The cab is of the all-steel box type and extends nearly the whole length of the underframing. It is built up of steel channels, angles and sheets properly braced and riveted together, and is entered through center doors at each end. Outside platforms are left at each end for the switchman to handle the trolley poles and are protected by side and end guard rails. In the interior the cab is open throughout as far as is consistent with the apparatus located therein. While the operating mechanism is grouped in the central section, it is not located in a compartment separate from the engineer's operating cabs. Convenient open passages run along each side between the operating positions in each end.

The two four-wheel trucks are a swivel type, designed for heavy freight work, and conform to M. C. B. standards. The side frames are built of heavy rolled bars for top and bottom members with cast-steel pedestals. The bolster, or center transom, is bolted rigidly to the side frames, and the entire weight of the truck framing is supported on heavy semielliptic springs hung by links to the double side equalizer bars, shown prominently in Fig. 1, which in turn rest on the journal boxes. The latter are a standard design with M. C. B. bronze bearings and

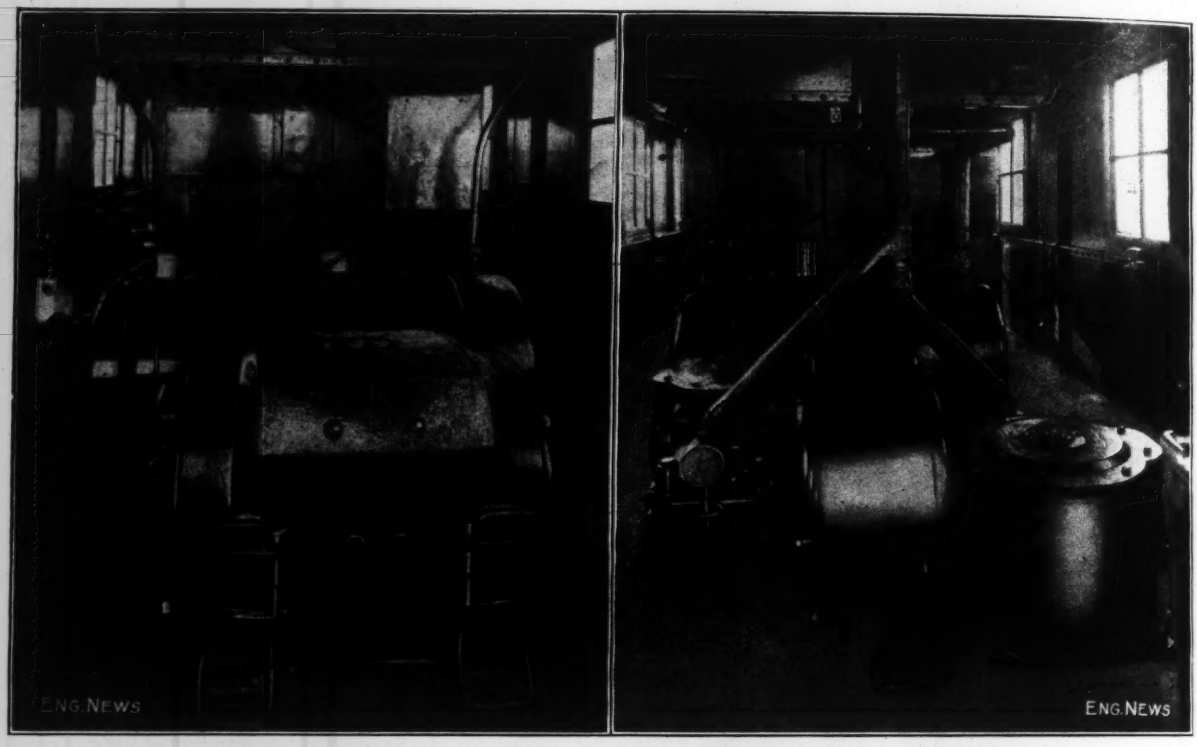
*From information furnished by the General Electric Co., Schenectady, N. Y., manufacturers and designers of the locomotives.

wedges. The wheels are solid rolled steel, 36-in. diameter, with M. C. B. treads and flanges. The axles are forged openhearth steel, of 6-in. diameter between the wheels and with 5½x10-in. journals. The air brakes are a combined straight and automatic type. The brake shoes are inside hung, and the rigging is proportioned for a shoe pressure of 85% of the weight on the drivers with 50 lb. pressure in the brake cylinders. Hand brakes are provided to hold the engine in the yard in case of loss of air pressure.

The motors are fully inclosed except for the ventilation inlets and outlets. The air is forced over the armature, fields and commutator, through the commutator spider and armature core to the exhaust openings in the bearing head. The continuous current capacity is 200 amp. under forced ventilation; 269 amp. can safely be carried for one hour. The continuous tractive effort is 11,200 lb., at rail head. The connection from motor armature to drive axle is by a single gear and pinion tooth, ratio 65 to 18.

Control equipment is of the "multiple-unit" (remote-switch) type, throwing the four motors into various combinations of series and series-parallel positions with resistance. The pairs of motors with their respective resistances are all connected in series on the first point of the controller. The resistance is varied through six points and finally short-circuited on the seventh or running point. The pairs of motors (in series) are then operated similarly in parallel and all resistance is cut out on the twelfth point, which is the full-speed running point. This provides control connections with seven steps in series and five steps in series-parallel. The transition between series and series-parallel is effected without opening the motor circuit, and there is no appreciable reduction in tractive effort during the change. This smooth transition between control points permits operating the motors close to the slipping point of the wheels throughout the entire range of acceleration without sudden fluctuations of tractive effort. Two switches are provided for cutting out either pair of motors, so that the locomotive can be operated with one pair of motors.

A new feature shown in this design is the arrangement of apparatus in the cab to afford better access for inspection, adjustment, etc. The main motor rheostat boxes are mounted in banks in an inclosed sheet-steel compartment in the cab center. This compartment extends from the floor to the roof and is accessible through doors opening into the passageways on each side. The floor in the compartment is open and it is surmounted by an open monitor deck. Thus there is a continuous draft of air rushing up through the compartment while the locomotive is running, which affords exceptionally good ventilation. The rheostats are formed of the usual cast-iron grids assembled in frames and insulated with mica.



FIGS. 2 AND 3. INTERIOR OF 1500-VOLT LOCOMOTIVE, G. S. & A. RY.
(Fig. 2, from No. 1 end; Fig. 3, from No. 2 end.)

At each end of the rheostat compartment and suspended from the roof of the cab in laterally inclosed steel frames, accessible through lift doors at the sides, are grouped the contactors and reverser. These are similar to the standard 600-volt design but with improved insulation.

Beneath these are installed on the floor, in the No. 1 end, the dynamotor, blower set and one of the air reservoirs, with the two air compressors and the other air res-

ervoir in the No. 2 end. All mechanism and circuits carrying 1500 volts are thoroughly insulated and protected from accidental contact. The motor-ventilating blower set has a capacity of 2000 cu.ft. per min. Air is taken from the exterior through a suction box with side louvres underneath the platform at the center. Current at 600 volts for the operation of the blower, and also the air compressors, the contactors and the lights, is furnished from the dynamometer. The compressors (two-stage, total piston displacement 70 cu.ft. per min., tank pressure 90 lb.) take air from the cab interior through screens and deliver to two 28x60-in. tanks in series. At each end of the cab is the engineman's seat, master controller, brake valves, bell and whistle ropes, sander, ammeter and air gages.

There is a pantograph collector, pneumatically controlled from the engineman's seat, working between wire heights of 14½ and 22 ft. For some lines where the pantograph is unsuited, trolley poles have been provided. The locomotives may have to operate on 500 and 600-volt lines and for such cases the auxiliary current supplies are obtained direct from the trolley circuit by a change-over switch, protected by a relay so that 1500 volts cannot be imposed on these circuits. There is a main fuse and a local fuse for each motor circuit. There is also in the cab an aluminum-cell lightning arrester. The principal dimensions and data are as follows:

Length inside of knuckles	37 ft. 4 in.
Length over cab	27 ft.
Height to trolley base	13 ft.
Width overall	9 ft. 7 in.
Total wheel base	26 ft. 8 in.
Rigid wheel base	7 ft. 2 in.
Track gage	4 ft. 8½ in.
Weight per driving axle	31,750 lb.
Weight electrical equipment	37,500 lb.
Weight mechanical equipment	89,500 lb.
Total weight on drivers	127,000 lb.

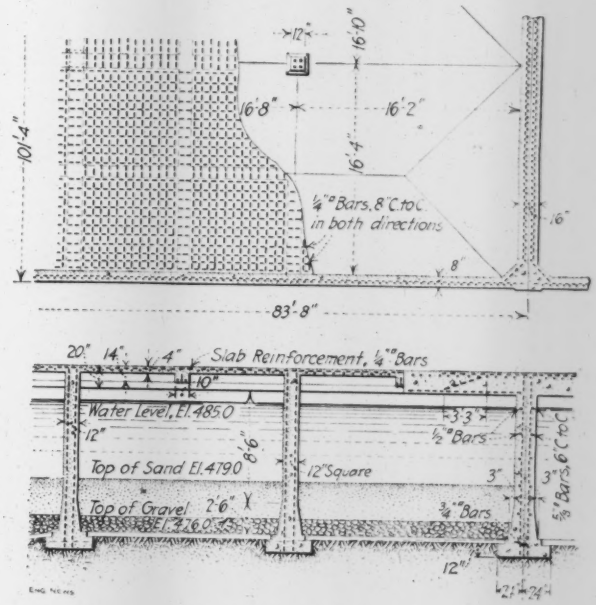
Reinforced-Concrete Filter Chamber for Coatesville Water Purification Plant

Usual practice in filter-roof construction is departed from in the design of the filter chambers for the new water-works of Coatesville, Penn., by the use of a beam-and-slab roof of reinforced concrete in place of the more common groined-arch roof. This roof is not covered with earth, but is left bare. Under these circumstances, a live-load of only 75 lb. per sq.ft. was figured for, and it was not necessary to have recourse to the large load capacity of arched-roof construction. The unsatisfactory experiences with many groined-arch filter roofs led the engineers to prefer the determinate structure formed by a combination of beams and cover slabs.

The filter plant will consist of two and later three filter chambers, each 83x100 ft., side by side. These are to be founded on the natural clay soil, and, therefore, unequal settlement may be apprehended. In order to reduce the length of monolithic construction, the dividing walls between adjoining chambers are double walls; that is, two adjoining filters are in close contact, but otherwise independent, each being designed as though it were distant from the other. In molding the concrete work, the wall of one chamber is to be carried up against outside forms and subsequently, in pouring the second chamber its concrete will be laid up directly against the back of the first wall. The construction involves a relatively slight increase of concrete over that in which the dividing walls are of single thickness only, and affords considerably greater security against cracking.

Some of the characteristics of these filter chambers are shown by the drawing herewith, taken from the design drawings prepared by Alexander Potter, of New York City, Consulting Engineer to the borough of Coatesville.

The roof consists of panels about 17x17 ft. The columns are reinforced, and are tied into the roof girders;



FILTER CHAMBER CONSTRUCTION FOR NEW COATESVILLE WATER-PURIFICATION PLANT

the footings are carried down below the floor slab and are independent of the slab. A girder system extends in both directions between columns. Subsidiary beams also run in both directions, in the center of the panels, making the slab element about 8x8 ft. The slab, 4 in. thick, is reinforced by rods running in both directions.

Manholes are formed in the slab at various points, to give access to the chambers for cleaning, etc.

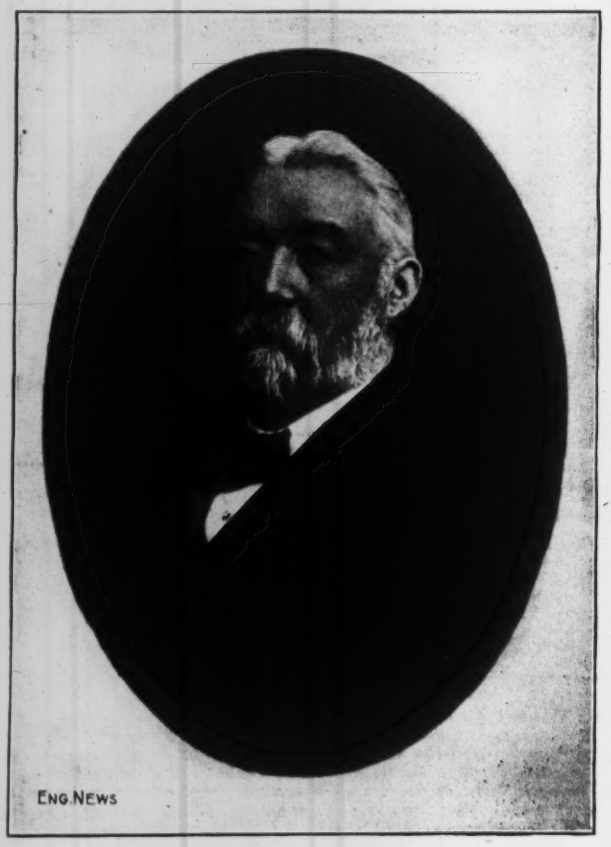
Extensive Municipal Improvements in Jerusalem are planned as the result of a large increase of population. According to a press dispatch from London, an electric street railway, electric light, and an adequate water supply will be provided. It is claimed that these improvements will necessitate the removal of the picturesque ancient walls and massive towers of the city.

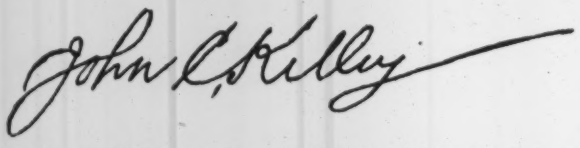
To the north and west of the old city there have sprung up during the last ten years large Jewish colonies, populous residential sections, as well as convents, hospitals, schools and other buildings, with a result that the greater part of the city is outside the walls. Four separate electric street-railway routes, all starting from the Jaffa Gate, the main entrance into the city, will run through the newer part of Jerusalem. A syndicate has been formed and concessions obtained. Construction work on the railways will commence in April. The syndicate has power to extend the line in any direction for a distance of about 25 miles.

The city walls, which have a circumference of about three miles and rise in places to a height of 38 ft. 6 in., are now being offered for sale as building material. Of late years Jerusalem has suffered from lack of fresh water. With the exception of a small quanity brought into this city from the ancient pools of Solomon, near Bethlehem, by means of a pipe line running along the old aqueduct, it is entirely dependent for its water upon the rainfall. Several new reservoirs are planned to supply the deficiency.

The Late John C. Kelley and the American Water Meter Industry

Probably few men in the water-works history of this country were more widely known and more universally liked than the late John C. Kelley, for 44 years President of the National Meter Co., whose death was briefly noted in our issue of Jan. 29, 1914. He was for many years a regular attendant at all the water-works conventions, and by his genial and hearty disposition won a host of friends and acquaintances among water-works officials and engineers. Indeed, so intimately connected was he with water-works history and with the introduction and use of water meters that a sketch of his business life is little else than an outline of the development of the water-meter industry.





John C. Kelley was born in Woodford County, Galway, Ireland, Apr. 17, 1839. His parents emigrated to America soon after his birth, and young Kelley's boyhood days were spent in Palmyra and Rochester, N. Y., and Cincinnati, Ohio, where he was educated in the public schools. Fortified by a genuine Irish optimism and a rugged pertinacity, he came to New York City to make his fortune; and there, in January, 1870, launched the National Meter Co., of which he was made President and of which he remained the active head until his death on Jan. 24, 1914.

In 1870, water meters were little used in American cities, and in many instances were decidedly unpopular, as an incident in Mr. Kelley's own experience illustrates. In the early seventies when he was not only the president of the company but its salesman and chief engineer as well, he was once on a missionary visit to Winchester, Ky. Here Mr. Kelley's suggestion of measuring water, a substance as free as air and illicit whiskey in "Old Kentucky," filled the superintendent of water-works with genuine fears for the water-meter manufacturer's life; and having taken a personal liking to Mr. Kelley, the water-works superintendent confidentially assured him that the safest thing to do was to take the first train north; for if his errand became known to the populace, he had a good chance of being filled full of lead! On the other hand, Mr. Kelley had no difficulty at all in selling meters to the water-works company at Concord, N. H., the superintendent of which was so delighted upon watching the movement of the recording dial, that he immediately ordered several meters without further test of their efficiency.

For the first ten years of its history, the National Meter Co. manufactured and sold only the "Gem" water meter, which is of the velocity type, invented and patented by Henry F. Read, of Brooklyn, N. Y., in 1869. At this time practically the only other meter in actual use was the old plunger-type Worthington meter. The objections to the early water meters were lack of accuracy, high cost, and their use for small pipes only. The first large-size "Gem" meters were two 4-in. meters ordered in the early seventies by the Jersey City water-works department. As this size was against all precedent, Mr. Kelley was almost reluctant to accept the order. These meters were sold for $500 each; the same size today costs $160.

Even at this period of water-works history, the economy of water meters and their influence in preventing unreasonable consumption were clearly appreciated by all wide-awake water-works officials; but although the first water-meter patent had been issued in 1837, and a hundred or more by 1870, a really popular meter was yet to appear. In 1878, the Chief Engineer of the Executive Board, of Rochester, N. Y., reported:*

> The great need of water boards all over the country is a durable meter, registering with reasonable accuracy, which can be furnished for about half the present prices. The fortune of any inventor is secured who can introduce such a meter; and when introduced, the water boards of most of our old cities can well afford, in almost all cases, to meter the water furnished their customers.

At the time this was written, over 600 patents had been issued in the United States for water meters and water-meter improvements. It is sufficient evidence of the difficulty of the problem presented that of all the types of water meters then invented, less than half a dozen were in anything like general use, or gave satisfactory results upon prolonged trial.

The difficulties of introducing water meters were increased by the opposition of many well meaning persons, based on the belief that the metering of water would lead to a reduction in the amount used and be detrimental to the health and cleanliness of city dwellers. This has always been the stock argument of those opposed to the introduction of meters, and it has been used with effect

*"Engineering News," Sept. 5, 1878, p. 282.

over and over again; and so recently as by the late Mayor Gaynor, of New York City.

It was early learned that many water-works departments were desirous of having a positive in preference to an inferential velocity type of meter. The problems which taxed the inventors of rotary meters to the utmost were: (1) to reduce the friction of the moving vanes or wheel to the lowest possible point; (2) to so direct the current of water upon the wheel that the latter would move with the least possible quantity of water; (3) to so construct the register that it would retard the motion of the wheel as little as possible.*

One of these pioneer investigators and inventors was Lewis H. Nash, of South Norwalk, Conn., with whom the National Meter Co. entered into an agreement, in January, 1878, to conduct a series of investigations with the object of perfecting a sliding piston device for a positive type of meter. Mr. Nash thoroughly tried out this principle, but finding it defective, abandoned it, and started anew. The company devoted a year to testing various devices, and its crowning effort was the meter which it appropriately named the "Crown" meter. This was in the latter part of 1879, and was but the beginning of the many water-meter inventions of Mr. Nash, who has ever since been Chief Engineer of the company.†

The "Crown" meter met with early and lasting success. The Water Commissioners, of Providence, R. I. (a city which as early as 1876, had fully one-third of its water services metered) tested a ½-in. "Crown" meter in 1880, approved and recommended it. For a long period, however, the introduction of water meters progressed very slowly and many arguments were necessary to convince city government officials that meters were an economy. In 1892, statistics collected by M. N. Baker,‡ editor of "The Manual of American Water-Works," brought out the following facts: of 2037 water-works only 98 had 20% or over of their taps metered, and these 98 water-works had about 61% of all the meters reported, or 109,478 out of a total of 163,178 meters. But eight of the 50 largest cities in the United States had 20% or more of their services metered. At this period, both the American and New England Water Works Associations were doing much educational work to prove to city officials the saving effected by the use of water meters.

A decade later, in 1901, a compilation made by Geo. I. Bailey, Superintendent of the Bureau of Water, at Albany, N. Y., showed that 23 large cities, with an aggregate population of 1,600,000 had from 50 to 100% of their services metered, 22 cities from 25 to 50%, 18 cities, 10 to 25%, and 71 cities, 0 to 10% metered.§ Mr. Bailey found:

> There is one result which stands forth preëminently, viz., that the average per capita consumption is twice as great as it should reasonably be, and that cities which are now in distress from danger of a water famine, and consequently are in search of additional supplies, can, by applying proper methods of conservation to their present supplies, more quickly and cheaply relieve themselves from their distresses, and by so doing have an abundant and adequate supply of water for twice as many inhabitants as they have now.

The steady accumulation of proof of the efficacy of water meters in reducing water consumption was accompanied by a steadily increasing demand for meters by water-works operating officers whenever they could obtain the necessary authority, and the next decade, from 1900 to 1910, was one of tremendous expansion in the meter manufacturing industry. In 1906, the National Meter Co. turned out its 500,000th meter. The same company sold its 1,000,000th meter in the latter part of 1913.

A compilation of the water consumption of American cities, made by Edward S. Cole, in a paper read before the American Water Works Association, in June, 1912,* showed 17 cities with 100% of their services metered; 56 with over 75% metered; and 78 with over 50% metered, besides many between 25 and 50%, out of a total list of 163 cities. Although these compilations are not strictly comparable, they show the great impetus given the water-meter industry during the past decade. The industry of which Mr. Kelley may almost be said to be the father and in which as time went on he had no little competition, now gives employment to thousands of men in no less than a score or more water-meter manufacturing establishments.

Devoted as Mr. Kelley was to his business, he found time for much philanthropic and civic work in his home city of Brooklyn, N. Y. His private charities were innumerable; it is said by those who knew him best that a tale of genuine distress never failed to open his heart and purse. Although more than ordinarily successful in his business, his mind was singularly free from guile, and was clean and pure. None ever heard profanity from his lips, and stories of doubtful character were never told in his presence by those who knew him and valued his good opinion. He was a member of the Board of Education of Brooklyn, and subsequently of Greater New York, for many years, and he never shirked a single civic duty, however pressed for time for business.

He was a man of great strength of character and positive yet genial in his manner. A favorite story which he often told of himself, and one that will be appreciated by all who were acquainted with him, was of his experiences on a jury "with eleven stubborn men, all of whom were opposed to his decision; yet everyone of them eventually came to his way of thinking."

*"Engineering News," Oct. 18, 1879, p. 336.

†A full description of the "Crown" meter and its principles may be found in "Engineering News," Nov. 29, 1879, p. 385, in an article by Mr. Nash.

‡"Engineering News," Jan. 16, 1892, p. 61.

§"Engineering News," Apr. 8, 1901, p. 280.

*"Engineering News," Aug. 22, 1912, p. 371.

A Compact 200-hp. Gasoline Engine will be used in the Rodman Wanamaker transatlantic aëroplane. The motor which is ready for installation is of the Curtiss V-type, eight cylinders each with a bore and stroke of 5x7 in. The cylinders are individual with welded waterjackets of noncorrosive monel-metal; each cylinder has four tungsten-steel valves, 2¼ in. in diameter with ⅞ in. lift. The thirty-two valves are operated from a single camshaft. The crank case is composed of two aluminum castings; the crankshaft, of Krupp steel, is 4 ft. long by 2¼ in. in diameter, and is drilled with an oil duct. The connecting-rods are I-type forgings with large bearings, with oil ducts to piston pins.

Water circulation is obtained by a centrifugal pump having a capacity of 40 gal. per min. Cylinder heads and valve seats are water-cooled, as are the exhaust-valve stems for nearly their entire length.

The lubricating system is handled by three rotary geared pumps. One large pump drives the oil under high pressure to every bearing through the main shaft, camshaft and connecting-rod, while two smaller pumps keep the lower half of the case drained. The gasoline intake manifolds are 2½ in. in diameter. A 2½ Schebler carburetor is used. It was essential that the dimensions of the engine conform to a certain space.

The engine was run at moderate speed for five hours on Mar. 7. At 1100 r.p.m., equipped with a 9-ft. experimental propeller, a static thrust of about 800 lb. is said to have been observed.

Field and Office

The author of the article, "Approximate Long Chords," printed on p. 570 of our issue of Mar. 12, is George Paaswell, Assistant Engineer, Public Service Commission, New York City. A printer's error, omitting his name, temporarily deprived him of credit for an ingenious short-cut in curve calculations. We apologize for the printer.

A Concrete Tunnel-Lining Car with Pneumatic Mixer and Placer

The accompanying views illustrate a new tunnel-lining car which has just been put in operation on the Chicago, Burlington & Quincy R.R. The car is self-contained, carrying on it the concrete material, the concrete mixer, and the method of delivering the concrete into the forms.

The outfit is mounted on a standard 40-ft. flat car. It consists of a pneumatic concrete mixer (of the type described in ENGINEERING NEWS, Aug. 10, 1911, p. 172), which is located on the floor of the car at about the middle, two material bins with their bottoms sloping down toward the mixer, a water tank, and a delivering pipe leading from the mixer out above the car. The mixer consists of a closed hopper into which the water, dry aggregate and cement are placed, and into which a blast of compressed air is then forced, blowing the aggregate and water through the pipe to the outlet, which it reaches as a mixed concrete.

The bins contain about 705 cu.ft. of space. They are used for the aggregate, which in general consists of bank-run gravel. They slope to the center of the car and discharge through chutes into a measuring hopper. This hopper is lifted and tilted to discharge into the mixer by means of a cable operated by a small air cylinder. The cement is stored in bags under one of the bins, which is 18 in. narrower than the car, leaving space for a man to carry the cement bags from under the bin up an incline to the mixer platform. The pipe which conveys the concrete from the mixer to the forms is 8 in. in diameter and runs from the mixer under the car and up at the end to the top of the bin, 14 ft. above the rail, and then on an incline above the car to a point about 24 ft. above the rail where, when it is in action, it enters through a bulkhead into the tunnel form. This inclined pipe is raised and lowered in order to clear the braces of the tunnel forms. The pipe is raised and lowered between guides by a cable attached to an air cylinder and when not in use the guides fall down and are left out of the way. The water barrel is located on the car and water is discharged from it through a pipe to the mixer.

In operation, the car is run into the tunnel with enough material for about 25 cu.yd. of concrete, and is connected to an air-supply line laid along the track at whatever point the work is to be carried on. Mixing, conveying and placing this quantity can be done in 1 hr. The crew consists of one operator, who operates the mixer and all the valves, one man to carry cement, one man to untie the cement sacks and dump the cement into the hopper, and one man to operate the hopper gates.

FIG. 1. LOADING THE HOPPER

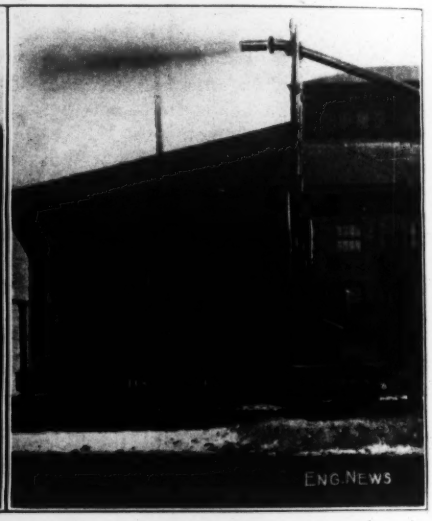


FIG. 2. SQUIRTING THE CHARGE

(Tunnel lining car, C., B. & Q. R.R. equipped with pneumatic concrete mixing and placing machine.)

Fig. 1 shows the hopper dumping the aggregate into the mixer in the middle of the car. Fig. 2 shows the concrete (in this case a test charge of gravel and sand merely) being blown from the outlet end of the discharge pipe. The car was equipped for the railroad by the Concrete Mixing & Placing Co., 123 West Madison St., Chicago, Ill.

Adding Three Stories to a Department Store

The Taylor store on Euclid Ave., in Cleveland, Ohio, occupies a five-story building, now seven years old. The building was designed for a total height of eight stories, the footings and columns being proportioned therefor; the idea was to add the three upper stories when required by the business of the store.

This increase in height is now being made, with no interruption to the business in the store. The accompanying view, taken the last part of January, shows the elaborate staging built up on the Euclid Ave. front of the

ORNAMENTAL STAGING TO EUCLID AVE., FRONT OF TAYLOR STORE, CLEVELAND, DURING STORY ADDITION

building to carry the workmen for the cornice removal and face-wall construction and shows also the highly ornamental sidewalk protection and hoist cages, which at the time the picture was taken were not quite complete. The store is on the main business street of Cleveland, and an attempt was made to make the necessary street obstruction and scaffolding as unobtrusive as possible.

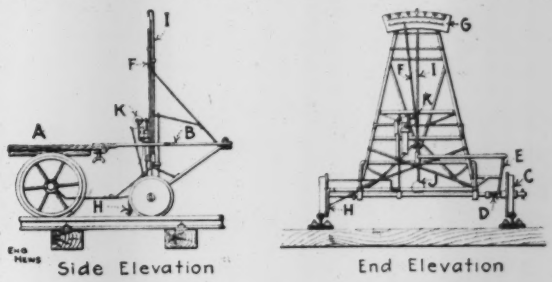
The reconstruction work involves some interesting features. The number of elevators in the old store was six; eight more are being added. It was necessary, however, to keep at least six elevators in constant service, and as the new elevators were immediately alongside the old elevator batteries it required some careful adjusting of the work to maintain a proper elevator service. Connecting the column extensions to the top of the old columns was also somewhat difficult, on account of danger of leakage. A portion of the roof immediately around the top of the old columns was first removed, and the new column addition placed on the plate there with no delay; immediately, a waterproofing layer was placed tight around the base of the new columns, so that no opening was left for the entry of water into the top floor, where the regular operations of the store were in progress. A further interesting feature in Cleveland was the fact that material had to be brought in on a busy street and immediately into the building, with no delay. This is quite common in New York and Chicago, when such construction is carried on, but in the smaller cities it is more common to pile the material around the building, and use it as needed.

The building was designed by J. Milton Dyer, architect, of Cleveland, who is in charge of the addition, which is being done by the Geo. A. Fuller Co. C. A. Lohmiller is the superintendent.

An Italian Track-Inspection Machine

A light machine for indicating and recording variations in gage and superelevation of track has been built in Italy and is shown in the accompanying cut. The apparatus is carried by a vertical frame mounted on bearings on a single axle and attached to a hand-car or small flat car *A* by a horizontal yoke *B*.

To indicate variations in gage, one wheel *C* is mounted on a sleeve riding on the axle and is held out against the rail by a coiled spring *D*, bearing against the sleeve and a collar on the axle. A vertical lever *E* is held with its head against the end of the sleeve and is connected to another vertical lever *F*, whose upper end forms a pointer traveling across a scale *G* at the top of



AN ITALIAN TRACK INSPECTION AND RECORDING MACHINE

the frame. The vertical frame carries a forked arm *H*, which rides against the opposite rail. Any variations in gage cause the wheel and its sleeve to slide upon the axle, and these movements are multiplied by the pointer and indicated on the scale.

To indicate the superelevation on curves, there is a second vertical lever and pointer *I*, pivoted near its lower end and carrying a heavy ball or weight *J* at that end.

This lever tends to remain vertical while the frame and scale tilt laterally due to the superelevation of the rails. The scale is graduated to show the amount of superelevation. Both levers have lever connections to pencils riding on a traveling sheet of paper *K*, thus recording the variations in gage and elevation of track.

The machine is the design of N. Iaforte, and is described in the *Rivista Tecnica delle Ferrovie Italiane.* A similar light and portable machine used on the Northern Pacific Ry. was described in ENGINEERING NEWS June 4, 1909. This formed a self-contained machine, being mounted on three wheels, like a track velocipede, but had not the high frame and large indicating scales of the Italian machine.

Tearing Down a Concrete and Steel Bridge Span

The accompanying halftones are from photographs of the bridge carrying Seventh Ave., in the Borough of Brooklyn, New York City, over the depressed tracks of the Long Island R.R. beaween 61st and 62nd St. and show, particularly in Fig. 2, some work which has recently been done tearing out the northerly span of this bridge to make way for the depression of the tracks of the Sea Beach R.R., a part of the Brooklyn Rapid Transit system which is being reconstructed and connected with the Fourth Ave. subway to form a through line to Coney Island as a part of the new dual subway system in New York City. The two tracks now crossing Seventh Ave. at grade are to be replaced by four tracks at a lower level and this makes it necessary to tear down the present northerly span, about 27 ft. long, and replace it by two spans which will each be about 33 ft. long.

FIG 1. BRIDGE OVER LONG ISLAND R.R. AT SEVENTH AVE. AND 61ST ST. BROOKLYN
(Removal work at far end.)

FIG. 2. CONCRETE FLOOR REMOVED FROM SEVENTH AVE. BRIDGE

The present Seventh Ave. bridge is 270 ft. long and carries a 44-ft. roadway and two 10-ft. sidewalks. It consists of eight spans, continuous from abutment to abutment over six pairs of prismatic concrete piers. The bridge consists of heavy transverse steel plate-girder floor-beams spanning the piers and carrying six main longitudinal girders and two fascia girders, all incased in concrete, with a reinforced-concrete floor slab 12 in. thick under the roadway and 7 in. thick under the sidewalks. The sidewalks have a granolithic finish and the roadway is paved with asphalt blocks. The concrete incasing the girders has a minimum thickness of 4½ in. and is bonded to the structural steelwork by means of loops of twisted rods ¼ in. square passing through holes punched in the web-plates of the girders, thus rigidly holding together the concrete on opposite sides. The top flanges of the girders come above the bottom line of the floor slab and are, therefore, surrounded by a large mass of concrete and this concrete has been assumed to carry its proportionate part of the live-load stresses in the design of the bridge. The bridge was built in 1910 and has been in active service since that time.

The work of tearing out the northerly span has been executed by first removing the roadway and sidewalk slabs from between the girders, then removing sufficient of the concrete incasing the girders to enable the longitudinal girders to be cut loose from the end transverse girder by knocking out the rivets in the connections in the ordinary way, and then cutting away just enough of this incasing concrete at the other end of the longitudinal girders to allow the latter to be cut away from the transverse girder, which is to remain standing, by means of an oxyacetylene torch.

In order to remove the old concrete, it was necessary to drill holes and use small charges of dynamite, thus shattering the material and allowing it to be knocked and pried to pieces by sledges and bars. All of these operations have shown the concrete to be of most excellent quality and have demonstrated that the methods adopted for bonding the concrete to the steelwork have been thoroughly effective. The concrete was not only effectively bonded to the structural-steel parts, but was so dense and free from voids that practically no rusting of the structural steelwork could be discovered anywhere.

The contractor advises that, to remove the concrete and knock out the rivets connecting the longitudinal girders with the end floor-beam, required the services of 12 men and a foreman, a total of 2080 man-hours and cost $750; to cut off the eight longitudinal plate-girders with the oxyacetylene torch required two men and outfit ten hours.

The work of cutting out the short pieces of longitudinal girders which have been left attached to the transverse girder which remains standing will be included in the contract for the new spans which has not yet been awarded. The new spans will be of the same design as the old structure.

The work of tearing down the old span here described,

was done by George W. McNulty, Inc., New York City, who is the contractor for the construction of the new depressed four-track line for the Sea Beach R.R. Both the original bridge and the proposed new spans were designed by J. B. French, Consulting Engineer, New York City.

Moving a Car Dumper 214 Ft.

By E. J. Knapp*

In order to make room for the new Detroit-Superior Viaduct, which is now under construction across the Cuyahoga River valley at Cleveland, Ohio, a 1000-ton car dumper, built for the Erie R.R., by the Wellman-Seaver-Morgan Co., in 1911, has just been moved out of the right-of-way of the viaduct about 214 ft. along the river to a new foundation. The dumper has a capacity of 224,000 lb. including the car and coal, and will dump about 30 cars per hour. It is 86 ft. high, 38 ft. wide, and 56 ft. long. The main structure is carried on four columns, which foot on concrete piers founded on piles. The cradle is carried on concrete columns rising about 16 ft. above the level of the main-column foundation. In addition to the main superstructure, there are boilers, mule hoists, cradle pan and engine, all on independent foundations. With the exception of the approaches, which were taken down, the entire structure and adjuncts was jacked up and moved as a unit to its new location.

In order to waste as little working time as possible, it was decided to move the structure between the Fall closing and the Spring opening this year, but it was rather difficult to get a contractor to undertake to move the structure intact. Finally, however, the John Eichleay, Jr., Co., of Pittsburgh, took the contract, and successfully carried it out during the past month.

The two accompanying views show the structure just previous to the moving. It is, in the views, jacked up on rollers ready to be moved. In preparing the plant for moving, the approaches were all taken down, the machinery, boilers, and other adjuncts were jacked up and placed on the I-beams and timbers, forming a continuous platform. The machinery and boilers, being on the landward side, acted as a necessary counterweight to the heavy cradle, which overhung on the river side.

Fig. 2 shows the dumper from the river side. As will be seen there, the main supports are

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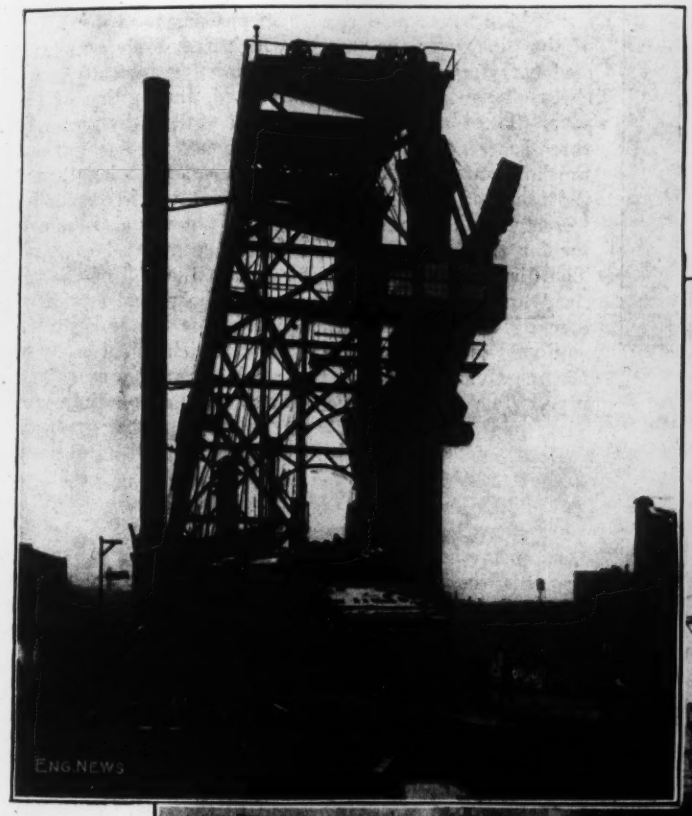


Fig. 1. View from New Location Just Before Moving

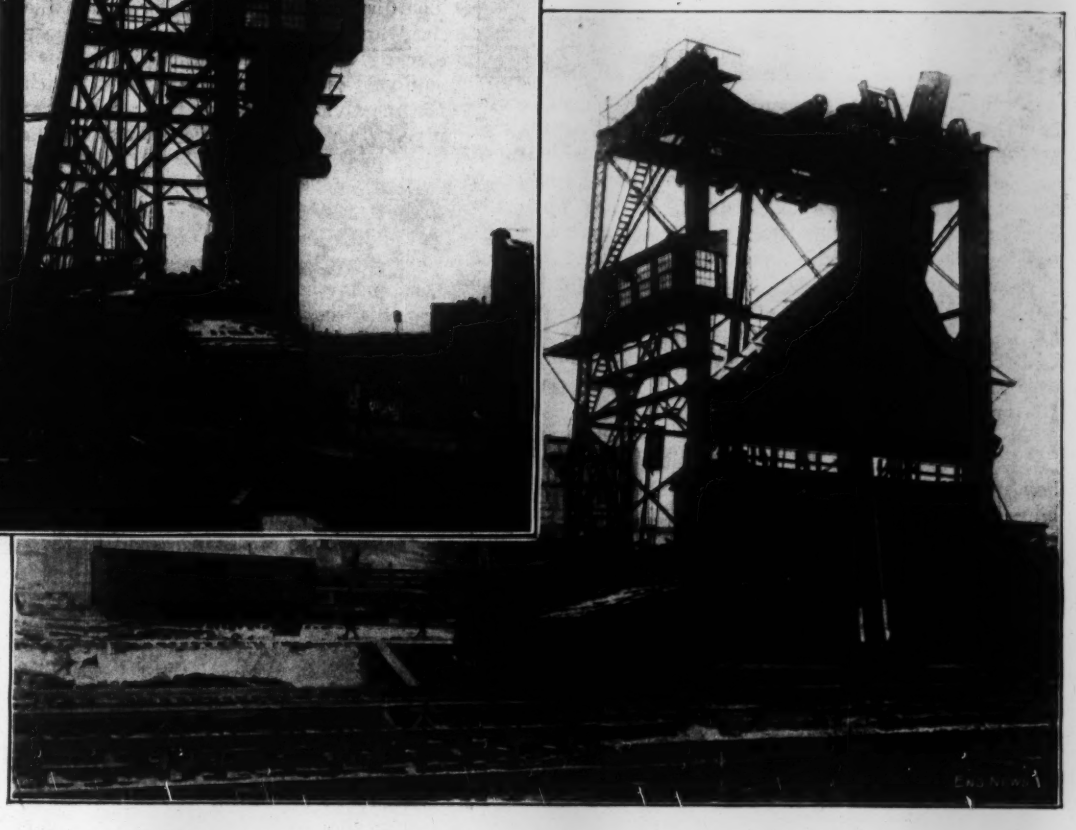


Fig. 2. River Side of Dumper Before Moving. New Location at the Left

transverse 24-in. 80-lb. I-beams, which were bolted in groups of two on either side of the river columns. The top flanges of these beams were cut out at the columns, so that the bases of the columns rested on the bottom flanges and the web of the I-beams lay flat up against the vertical plates of the columns. These I-beams rested on longitudinal 12-in. 31½-lb. I-beams running parallel to the river and resting in turn on the rollers which rolled on a runway built up on timber cribs. In the rear, the slanting columns were handled in the same way, except that 12x12-in. timbers were used instead of the 24-in. transverse beams. On account of the batter to these columns, they were supported additionally by drum posts (timbers with screwjacks at the end) which carried the load of the columns at about their midheight, vertically down to the platform. In addition, drum posts were placed under the center of the pan and under the cradle. The cradle was lashed to the upper works. The 12-in.

CROSS-SECTIONER FOR 11¼-FT. PIPE

31½-lb. longitudinal beams formed a floor on which were carried the machinery, boilers, brickwork, coal bin, house, and all other separate units, so that when the machine reached its new site, all that was necessary was to let each unit down into its proper place.

Previous to the moving, the final foundation for the dumper had been prepared, as shown to the left in Fig. 2. This foundation consisted of the regular pile footings with concrete piers at the proper places. The runway over the final foundation consisted of transverse 18-in. I-beams and longitudinal 10-in. I-beams, forming a platform on a level with the platform of the old foundation.

The procedure was first to jack up the structure a height of 35 in., second, to build the platform and cribbing described above, third, to haul the structure to its new position, and fourth, to jack it down to its final level. To raise the different units, 230 jackscrews were used and 350 8-in. rollers were required. The motive power was furnished by two winches each pulled by a team of horses. The hauling lines were reeved in five-sheave blocks. The actual moving and lowering consumed about 5½ days. A total of 27½ days was required for preparing the structure for the moving. After the machine had moved 44 ft., a settlement of ⅛- in. was noted, and at the 120 ft. mark the settlement reached the total of ¼ in., but this was the only settlement noted, and the machine was finally placed without any trouble.

The writer wishes to thank Emil Dauenhauer, the superintendent for the contractor, for data.

Cross-sectioner for Circular Conduit

BY ARTHUR W. TIDD*

One special type of aqueduct built by the Board of Water Supply on the new Catskill supply for New York City consists of 11-ft. 3-in. riveted steel pipe encased in a concrete envelope and lined with cement mortar. The pipe was delivered on the ground in 7½-ft. or 15-ft. sections, which were rolled into the trench, placed on concrete cradle blocks and riveted together. The pipe varied in thickness according to the hydrostatic head, from $\frac{7}{16}$-in. plate, lap-jointed, to $\frac{9}{16}$-in. plate, butt-jointed. The empty pipe flattened slightly under its own weight, and it was desirable to obtain a true record of the amount, distribution and shape of the deformation after it was in place and riveted. To obtain this information the cross-sectioner described in this article was constructed in one instance and an actual cross-section of the inside of the pipe taken at various stations.

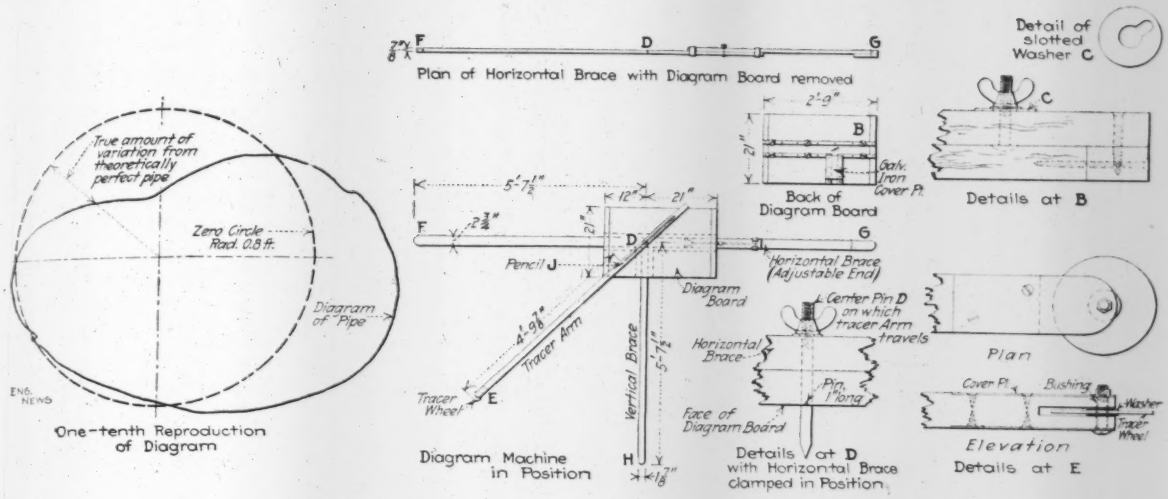
The instrument (see view, Fig. 1, details, Fig. 2) consisted of a board held rigidly in position near the center of the pipe, over the face of which a movable arm traveled carrying a pencil which recorded graphically, on a sheet of paper pinned to the board, the outline of the pipe. The instrument was held in position by means of three braces, the vertical brace being of fixed length and the horizontal brace having one end of fixed length and the other adjustable. The center line of the braces intersected on the center pin *D*. The pin was also the center for the tracer arm and for the completed diagram. The distance from the center pin to the end of the two fixed braces was 5 ft. 7½ in., the theoretical semidiameter of the inside of the pipe. The tracer arm was equipped on one end with a wheel which rolled easily on the metal as it traversed the full circumference of the pipe. The other end was slotted to slide on the center pin *D*, for a distance sufficient to take the maximum distortion, and at an intermediate point carried the pencil *J* that marked the outline on the sheet of paper pinned to the diagram board.

In operation the instrument was set up at the required station, brought into position at right angles to the axis (in this case an easy matter by referring to the circumferential joints of the pipe), securely held by extending the adjustable end of the horizontal brace, and the sheet of paper pinned to the board. The tracer arm was then revolved around the pipe, the pencil *J* marking the outline. The diagram was then complete as far as the field-work was concerned. In the office, the zero circle was drawn, of radius 0.8 ft. The distance between the zero circle and the diagram, measured on a radial line, is *the actual amount of the variation* of the pipe from an 11-ft. 3-in. circle.

Design of Instrument—The width of the board was fixed by the fact that access to the pipe was through manholes whose clear diameter after lining was 22 in. This width in turn determined the location on the board of the center pin and the determination of the radius of the zero circle. Since one side brace and the lower brace were of fixed length, all the distortion was thrown to the right half of the diagram, necessitating more space on that side of the board.

For ease in transportation, the apparatus was built

*Section Engineer, Board of Water Supply, New York City.



PIPE DIAGRAM AND INSTRUMENT WHICH MADE IT

knockdown. The horizontal brace was readily and quickly attached to the board by means of the wing nuts and slotted washers, the slotted washers being slipped back, the brace dropped into place, the washers slipped forward onto it and the wing nuts tightened. The vertical brace was simply inserted under the galvanized-iron cover-plate and pushed up to a bearing against the horizontal brace. The tracer arm was held against the face of the board by a light pressure of the hand as it was revolved, the pressure of the pencil on the paper being automatically maintained by means of a rubber band.

The machine was entirely home-made except for the tracer wheel and its brass fittings. Kiln-dried white pine, No. 1, was used for the lumber which, when finished, was well filled with linseed oil. The machine, as can readily be seen, is capable of almost any modification to fit almost any case. It is light, quickly built, not expensive and requires only materials available everywhere. There is nothing to get out of order in the field and no closely fitting joints to swell up and stick. The results are amply close enough for almost any purpose and easily converted into convenient form for any desired study or investigation. A much more elaborate instrument designed for similar work is described in ENGINEERING NEWS, for Mar. 3, 1910. In this machine, the wheel on the end of the arm is connected with the pencil through a set of reducing gears whereby the pencil traces the diagram exactly *to scale*.

The author claims no originality in the design of the home-made machine described other than the devices for making it quickly collapsible and yet stiff enough to stand up under the wear and tear of service.

Concrete Surfaces on the Connecticut Avenue Bridge, Washington, D. C.

Within the past few months there have been rumors current that the concrete surface of the Connecticut Ave. bridge across Rock Creek Valley, at Washington, D. C., was showing signs of deterioration. These rumors gained considerable credence on account of a statement made in *Professional Memoirs, Corps of Engineers, U. S. Army, and Engineering Department at Large* for January-February, 1914, by Col. F. V. Abbott, Corps of Engineers, U. S. A. Col. Abbott said:

> The Connecticut Ave. bridge over Rock Creek in the city of Washington is built of concrete in mass and to give it an attractive surface it was bushhammered. When first finished it simulated the appearance of granite perfectly. After the first winter much of the surface layer scaled off, leaving the embedded stones exposed, destroying the similarity to a natural stone.

We have since learned that Col. Abbott's statement in effect was directed to the condition of the bushhammered surfaces of the posts supporting the handrail and to the pedestals under the concrete lions which ornament the four balustrade entrances to the bridge and did not mean to indicate any serious structural deterioration of the bridge nor any deterioration of the surfaces of the bridge proper.

A careful examination of the part of the bridge referred to by Col. Abbott shows that there has been some pitting in a few places covering very small areas. Where the broken stone in the concrete has protruded through the mortar surface the faces of these stones bear the marks of the bushhammer, indicating beyond doubt that the mortar was not consequently scaled off. In regard to the remainder of the bridge, the entire surface is substantially in as good condition today as the day the stone was set and the minor defects can only be found by the most careful and minute examination of the surface.

The surfaces of the concrete lions have deteriorated somewhat. This is no doubt due to the various chemicals in the compounds which were used to give the concrete a characteristic color and texture as well as to water-proof it.

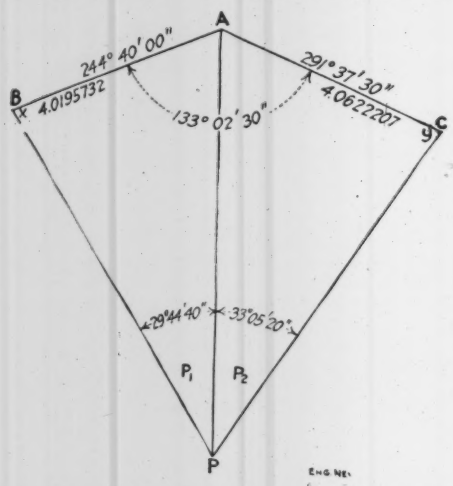
Col. Abbott's statement was misleading in one other regard. The surface of the Connecticut Ave. bridge is not in imitation of granite, except in the quoins and arch-ring stones, which were cast as separate blocks and finished as cut stone is finished. The main surface between these stones, which protrude about an inch from the main surface, is a bushhammered surface, but the aggregate is a yellow sand and stone which does not simulate granite in any way.

Simple Analytical Method for the Solution of the Three-Point Problem

By D. L. Reaburn*

The analytical solution of the three-point problem by the usual methods is somewhat laborious (see Johnson's "Surveying" and U. S. Geological Bulletin No. 234, p. 13). I have had occasion to use this solution a great many times in my 20 years' experience, and have always felt that in view of the easy graphical solution by the cut-and-try method with the planetable, that an analytical solution could be made in the same manner.

On a recent trip to South America I did not have the formulas with me and worked out the method described below. With this new solution it is possible when working in a region where a triangulation system exists and



the signals are visible, to place the transit on azimuth for traverse work within five or ten minutes, with a degree of precision equal to a Polaris observation, and to determine the relative position as well.

Let ABC be the three points of known position, and P the point of required position.

Let the unknown angles at B and C be represented by x and y and the observed angles by P_1 and P_2.

We then have:

$$x + y = 360° - (A + P_1 + P_2) \qquad (1)$$

$$PA = \frac{BA}{\sin P_1} \sin x = \frac{AC}{\sin P_2} \sin y$$

$$\frac{\sin y}{\sin x} = \frac{BA \sin P_2}{AC \sin P_1}$$

$$\log \sin y - \log \sin x = \log \left(\frac{BA \sin P_2}{AC \sin P_1} \right) \qquad (2)$$

It is evident that if the correct value of either one of the angles x or y, or of the azimuth of either one of the lines PB, PA or PC can be determined, the problem will be reduced to a simple solution of the triangles APB and APC, and the two resulting values for the length of the line PA will be the same. It is also apparent that any error in the assumed angle or azimuth will produce two values for the computed length of the line PA.

In the graphical solution of the problem with the planetable by the cut-and-try method the error in the assumed azimuth results in a triangle of error in which the logarithm of the side parallel to PA is the difference between the first and second members of equation (2), and this triangle of error is then reduced to zero by successive assumptions and trials.

An analytical solution may be made in the same manner by assuming values for the angles x and y to satisfy the conditions of equation (1) and then reducing the error in the assumption, by successive approximations, until the difference between their log sines is equal to the second member of equation (2).

For example, suppose the known and observed parts to be as shown in the figure. We then have:

$$\frac{x + y}{2} = \frac{360° - (A + P_1 + P_2)}{2} = 82° 3' 45''$$

log BA	4.0195732
log sin P_2	9.7371445
colog AC	5.9377793
colog sin P_1	0.3044025
log sin y — *log sin* x =	9.9988995
log sin x — *log sin* y =	0.0011004
log sin 83° — *log sin* 81° =	0.0021308

Approximately,

$$\frac{x - y}{2} = \frac{\log \sin x - \log \sin y}{\text{diff. in log sin for } 2°} = \frac{11004}{21308} = 0.517° = 31'$$

1st approximation:

$x = 82° 34' 45''$ *log sin* = 9.9963472 Diff. for 1" = 2.55

$y = 81° 32' 45''$ *log sin* = 9.9952551 Diff. for 1" = 3.45

0.0010921 Diff. for 2" = 5.90

0.0011004

$$\text{Error} = \frac{83}{5.9} = 14''$$

Therefore:

$x = 82° 34' 59''$

$y = 81° 32' 31''$

Azimuth $PB = 146° 12' 31''$

If the azimuth be required to the nearest minute only, for orienting the transit, 5-place logarithms will be ample, and the numerical work will be considerably reduced.

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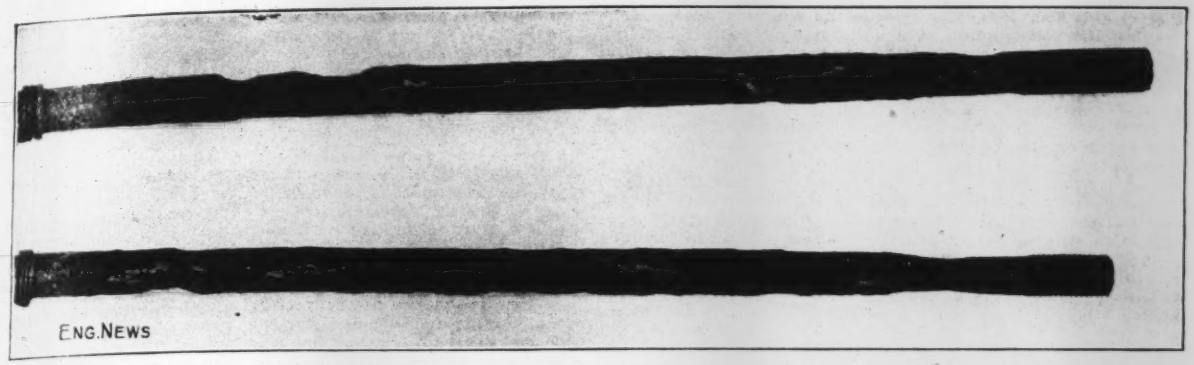
Extreme Corrosion of Elevator Piston-Rods

In a pair of elevator piston-rods recently taken out of the elevator machine in a 5-story building in New York City, remarkable corrosion was exhibited. The corrosion affected only that part of the rods which always remained inside the cylinder, never passing through the stuffing-box. The elevator in question, installed in 1891, is of the vertical gravity type, is reeved two to one, and has a capacity of 1500 lb. In this type of elevator the counterweighting was often provided by a follower on the piston-rod within the cylinder, but in the present case the follower was not used, as independent outside counterweights were provided. Thus a length of 3 to 4 ft. of rod always remained inside the cylinder, the piston being this distance below the upper cylinder head when the elevator was at the bottom of its travel. The rods are of 1½-in. original diameter, and are about 30 ft. long.



INNER END OF TWO ELEVATOR PISTON RODS REMOVED FROM A HYDRAULIC ELEVATOR IN NEW YORK CITY
(Rods 1½ in. diameter, original length about 30 ft. Threaded end is the piston end. The limit of corrosion is at the left edge of the picture.)

The operating engineer of the building has been in his present position for some seven years and during this time the rods had not been removed or exposed for examination. Recently, the city's elevator inspector noticed that when the elevator was at the bottom of its travel the portion of the rod showing just about the stuffing-box seemed much pitted. It was also learned that the engineer had much difficulty in keeping the stuffing-box tight. Examination of the piston-rod was therefore ordered. The result is shown in the photographic view reproduced herewith.

The need for frequent inspection of such concealed parts subject to corrosion is strikingly evidenced by the picture. The Bureau of Buildings, which has charge of elevator inspection, is considering the formulation of a rule to fix how long such rods should be allowed to remain before examination. It is understood that in the best practice in New York City buildings having passenger elevators, the rods are removed and examined after the first five or six years, and then are examined every two or three years.

Settlement of Sand Substratum under an Irrigation Ditch

BY CLAIR V. MANN*

A peculiar case of settlement which followed immediately upon the opening of a new irrigation ditch may be of interest to engineers.

The ditch referred to was about 15 miles long and was designed to carry about 125 sec.-ft. of water. About one-half mile below the headgate the ditch crossed a firmly compacted deposit of boulders and gravel intermixed with clay, which in ages past had been washed in from a neighboring ravine. A short time after the water reached this point an area some 200 ft. in length and 30 ft. in width on each side of the canal settled a distance of about 8 in. The settlement occurred evenly over the entire area, the boundaries forming a true fault. After this initial settlement, no further movement was noticed. The embankments were high enough so that no break in the ditch occurred.

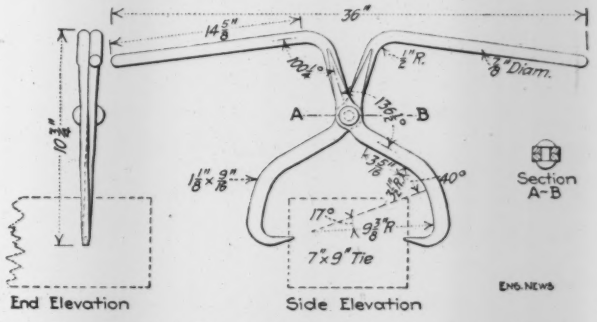
In discussing the probable cause of the settlement, it was learned that a similar incident had taken place on another ditch within the same district and that a test pit sunk had revealed a local deposit of fine, white sand which had in some way settled under the influence of the water.

As no further settlement has occurred on the ditch and as time did not permit of further investigation, the cause of settlement in the present case has not been determined. It is likely that a similar condition would be found as in the case of the ditch where the test pit was sunk.

*Civil Engineer, Boulder, Colo.

Tie Tongs: Philadelphia & Reading R.R.

For convenience in handling ties the Philadelphia & Reading R.R. uses the tie-tongs shown in the accompanying cut, and which are a modification of the rail-tongs used in handling rails. They are made of wrought iron, the handles being round (⅞ in. diameter) and the blades



TIE TONGS; PHILADELPHIA & READING R.R.

flat ($1\frac{1}{8} \times \frac{9}{16}$ in.) with blunt points to hold the tie. The pivot is a ¾-in. rivet. This tool is standard design recently adopted, and for drawings we are indebted to Wm. Hunter, Chief Engineer, Philadelphia & Reading R.R.

NOTES

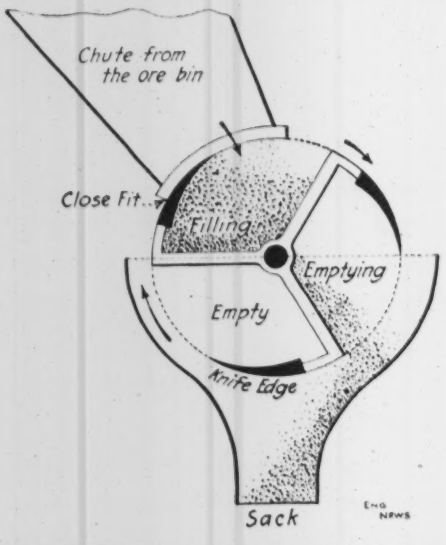
The Field Museum Building in Jackson Park, Chicago, is in very dilapidated condition as to its exterior, which leads to criticism on the part of visitors, but investigation shows that this applies only to the plaster covering and that structurally the building is in good condition. It was originally the Fine Arts Building at the Columbian Exhibition, 1893, and was built of brick in order to make it fireproof and to meet the insurance requirements in view of the value of the con-

tents. Later on, when the Field Museum of Natural History was established, this was selected as the temporary home, pending the construction of a handsome permanent building in Grant Park. The construction has been delayed for several years, however, by litigation over the site, but this has been settled, and it is expected that this building will be erected within about three years.

The brick walls of the present building were covered with the "staff" or plaster composition which was used for all the exhibition buildings, and this covering is gradually falling to pieces, having reached the limit of repair. The attempts to improve the outside appearance of the walls have ceased, after it has been conclusively proved that such efforts were unsuccessful, and the introduction of new plaster in patching seemed to loosen a larger area than was repaired. The repainting and calcimining of the exterior received considerable attention during 1907-10, and a contrivance introduced by Mr. Akeley (the museum's taxidermist) seemed to have solved the problem.

The entire north front of the museum and most of the two annexes received an application of stucco which greatly improved the appearance. A year after the treatment, the north side of the building gave little evidence of the undertaking. The machine applied liquid stucco to the exterior surface of the walls with compressed air, and this was one of the first applications of the "cement gun." For several months the result seemed successful, both in holding to the plaster and in preserving a uniform color. But the lifeless plaster and the decayed surface of the staff would not hold the hardened stucco, and while the general appearance of the building was much improved, it seems that nothing more can be done to protect or conceal the decomposed plaster and staff with which the brick walls of the building are covered. For this information we are indebted to D. C. Davies, Assistant Secretary of the museum.

A Sack-Filling Machine of simple design (see cut) was described by T. R. Archbold in a paper before the Institution of Mining and Metallurgy, on Feb. 19. Its special application is the filling of ore sacks. The ore passes from the ore bin through a chute which fits snugly on the circumference of the drum, as shown in the cut. The drum, divided into six



compartments, revolves in a two-part hopper which allows three of the drum sections to empty into each side of the hopper and thence into two sacks. This machine with three men can fill 360 sacks per hour, a task requiring 15 men with shovels. The capacity of the machine can be increased by lengthening the drum.

Placing Temporary Steel Shaft-Lining—A riveted steel lining as temporary protection means was placed in the cast-iron shaft of water-works crib No. 3 at Cleveland, Ohio, recently. The lining is 110 ft. long, made in 22 5-ft. sections, but on account of the peculiar erection method each section was brought to the work in halves, field-riveted together. The erection was done in the shaft, but at the surface, holding the erected portion by hoist chains, placing an additional section of the lining, then lowering 5 ft., then placing the next section, etc. The sections had to be in two parts so that they could be placed around the hoist chains. When eight sections, or 40 ft., of the lining had been [illegible] lining was blocked up, the chains released, [illegible] again near the top of the lining, after which [illegible] and lowering proceeded. The Van Dorn Iron [illegible] Cleveland, did the work. The total weight [illegible] about 70,000 lb.

Curve Intersection Problem—When two curves intersect, to change one of the curves to a curve of [illegible] between the same tangents, is a problem [illegible] B. L. G. Rees in our issue of Feb. 26, p. 467, [illegible] given. The method of coördinates which Prof. C. Frank Allen, Boston, recommended as preferable for [illegible] p. 573, Mar. 12, is also recommended by S. N. [illegible] attle, Wash., who outlines the method of solution on the basis of coördinates in a manner practically identical with that of Prof. Allen.

Mr. Daugherty further points out that, when location in the field is to be done, nothing further will ordinarily be needed than to compute the tangent length between original and revised curve; that is, the distance forward or back along the tangent from the original curve to the substituted curve of different radius. This is equal to the difference of radii times the tangent of half the supplement of the tangent-intersection angle. Referring to the sketch, p. 573 of our issue of Mar. 12, the distance in question is ED or OA, which is equal to $(R_1 - R_2)$ cot ½ $(180 - \Delta)$. With this the new P.T. is located and the curve can be run in, tied to the intersecting curve, and the angle at intersection measured.

K. A. Westholm, Detroit, Mich., suggests a coördinate method of different kind. Assuming an origin of coördinates, analytic-geometry equations can be written for the three curves, and their intersections located by solution of pairs of the three equations. Having the coördinates of the intersections, other elements of the problem are readily computed.

A New Acid-Proof Tank-Lining being tried out in practical use by the Chile Exploration Co., who operates copper mines at Chuquicamata, Chile. The lining is an especially prepared acid-proof asphalt mastic, and after a year's laboratory tests under as nearly operating conditions as possible, it has shown no deterioration. The company's copper ores in Chile are handled by sulphuric acid leaching and electrolytic deposition. After crushing, the ore is put into large tanks and leached with 10% sulphuric acid for 24 hours. From the electrolytic cells the spent electrolyte, high in sulphuric acid, is returned to the leaching tanks, ready for extracting the copper from a fresh batch of ore. The company recent placed an order with the Barber Asphalt Paving Co., Land Title Building, Philadelphia, for sufficient asphalt mastic to line several concrete leaching tanks, 15 ft. deep with outside plan dimensions of about 110x150 ft. The first lot of the material has already been shipped.

An Unusual Surveying Problem—Two friends in Pittsburgh, Penn., send us the following newspaper clipping, which describes an incident illustrative of the temporary nature of the work of man, since even a patch of the earth's surface nailed down with conscientious surveyors' hubs (technically known in law as "real property") has been found an elusive possession:

Several surveys of properties on the north side of Penn Ave., between Highland and Collins Aves., East Liberty, have disclosed the fact that buildings on them are anywhere from 6 to 12 in. over the adjoining property line, and that the overlap is on the east side of lots. A surveying firm, which has surveyed a number of properties in the square mentioned, says the trouble is no doubt due to a quicksand formation and that the slip is general. As the squares are built up solid, to put every building just where it should be, would necessitate the moving or tearing down of all. The only other way to correct the trouble is for the buyers of a property to purchase whatever amount of ground a building overlaps.

The Construction of Large Brick Chimneys is a job for skilled workmen. The taper, which sometimes changes several times in the height of the stack, is determined by a template of triangular form, having a plumb line and bob on the vertical side and a spirit level on the horizontal (top) side, the third side being cut to the proper angle. The work is checked frequently by the inspector, who makes measurements of the interior diameter. The bricklayers work on a platform supported by two or four cross timbers. An upright post fastened to the inside of the stack projects above the platform and carries a horizontal timber (with inclined braces), having a pulley at each end. The hoisting line from an engine on the ground passes over these pulleys and down inside the stack, the material being hoisted generally on the inside. If it is to be hoisted on the outside, the cross timber is made long enough to carry the pulley clear of the base of the stack. (From a paper on "Brick in Engineering," by E. E. R. Tratman, read before the National Brick Manufacturers Association.)

Editorials

The Relative Rating of Bookkeepers and Sanitary Engineers in Massachusetts

A remarkable contrast in the salaries paid to engineers and to clerks under certain civil service conditions is illustrated in two examinations held on Feb. 26 and Mar. 2, respectively, by the Massachusetts State Civil Service Commission. The first was for the position of Sanitary and Hydraulic Engineer on the State Board of Health; at salaries ranging "from $60 per month up." The other examination was for the position of Bookkeeper in the service of the city of Newton; "the salary is $1200 per year." The relative qualifications required of candidates for the two positions is evident from the following excerpts from the Civil Service Commission's advertisement.

ENGINEER ($60 per month)
The examination will include mathematics, the same as for civil engineers of Grade A (this grade requires at least three years' good experience, or graduation from some reputable technical school, with at least one year's good, practical experience); engineering theory, the same as for civil engineers of Grade B (this grade requires at least six years' good, practical experience, or graduation from some reputable technical school, together with at least four years' practical experience); papers on water supply, water purification, sewerage work, sewage disposal, sanitation, and design of some sanitary engineering work.

BOOKKEEPER ($100 per month)
The examination will include letter writing; arithmetic (cost accounting and municipal accounting); rapid computation; handwriting; accuracy test; bookkeeping.

Comment to the readers of ENGINEERING NEWS seems superfluous. We can only make the suggestion that the matter be referred for due consideration to the Committee of the American Society of Civil Engineers on the conditions of employment and compensation of engineers.

Broadening the Meaning of the Term "Engineer"

Most engineers who practice engineering as a profession believe that the term "engineer" has far too broad a use. We have published frequently letters to that effect from engineers who object to being classed with engine-drivers, cranemen, stake-drivers, concrete foreman and the like. With the constantly increasing number of business specialties, new kinds of "engineers" are constantly popping into print, whose connection with real engineering is far-fetched to say the least.

The newest brand to come to our attention is the "rural life engineer," who, according to the Atlanta *Constitution*, has become "a new and vital element in the development of country districts." The *Constitution* says further: "He goes into rural communities, analyzes their life, their pursuits, their pleasures and their needs, and cures defects and builds character by living among the people." It is explained that this work is being taken up by the Young Men's Christian Association, which sends out country secretaries, or "rural life engineers," men who "are generally college-trained with agricultural educations."

We do not question for a minute the good work done by these country secretaries, but to call them "engineers" is overworking a much abused name. Perhaps it illustrates not only a misuse of words but a popular fallacy, very current nowadays, that all the problems of the human race may be investigated, studied and analyzed with mathematical precision, and solved and remedied and cured by the use of statistics and data with as much ease and certainty as engineering problems are solved, or as the public thinks engineering problems are solved!

Secretary Lane Favors Better Protection for Inventors

Following a recent court decision sustaining some of the foundation patents on aëroplane construction taken out by the Wright Bros., a statement has been issued by Orville Wright, reciting the long fight which he and his brother carried on to sustain their rights as pioneer inventors. The salient feature in the statement is the long delay and great expense which have been involved in the suits brought by the Wright Bros. against those who wilfully and for profit infringed their patents. Mr. Wright declares that it was the long continued strain and worry over this patent litigation which undermined the health of his elder brother, Wilbur Wright, so that he fell a prey to disease.

Mr. Wright's statement is in substance an indictment of the American patent system for its failure to furnish adequate protection to the *bona fide* inventor. Similar statements by other inventors have been many times published, but Orville Wright's story makes a powerful appeal to the public because the invention to which it refers is one which has taken strong hold of the popular imagination.

To what extent the Wright Bros.' success in flight was due to skill and to what extent to radically novel mechanical construction, capable of protection by patents, we do not, of course, attempt to say; but that the Wrights were the pioneers in the field of aviation is known all around the world, and there is little public opposition, we believe, to sustaining the monopoly on inventions of this sort which is granted under the patent system.

It is stated further that Mr. Wright's published statement has come to the attention of Secretary Lane, of the Interior Department, who has written to Wright declaring himself in favor of a revision of the patent laws so that they will afford more adequate protection to the inventor. In view of the organized effort to undermine the patent system which has been made in Congress during the past two years, it is fortunate that some forces are in operation which will tend to strengthen it. It is

as needful to protect and encourage the *bona fide* inventor and those associated with him who have spent capital and enterprise in pioneer work as it is to discourage those who misuse the patent system to carry on blackmailing litigation.

Politics vs. Business in New York State Road Work

The results of an investigation of New York State highway work carried on by Governor Glynn's special commissioner, James W. Osborne, is reported elsewhere in this issue. Mr. Osborne's report shows that the reasons why the contract work on New York State highways has resulted in scandal and disgrace is because of the system by which it is carried on. Mr. Osborne judges correctly that it is far more important for the people of the State of New York to know wherein their plan of carrying on State work is defective than it is to know which particular contractor or engineer or State official was guilty of fraud. Mr. Osborne shows in the plainest terms possible that when State road work is carried on by and for a political machine, the State is bound to be a heavy loser through lack of efficiency and fraudulent dealings.

It is, however, of little use to indict a system as bad without suggesting something to take its place. Mr. Osborne, therefore, supplements his indictment of the present political control of road work by the outline of a plan whereby State road construction and repair can be carried on as a business and not as a political game. The plan proposed by Mr. Osborne is closely similar to that suggested in these columns in our issue of Feb. 19 in an editorial entitled, "The New York State Highway Department: after Investigation, What?" Briefly stated, Mr. Osborne proposes to have the entire State road work put in charge of a commission made up of eight men to be appointed by the Governor, one from each judicial district of the State. These men would give their services without compensation and their chief function in fact would be the selection of a high-class engineer to have entire charge and authority as an executive over all the work of State road construction and repair.

Excellent as is the general principle involved in Mr. Osborne's recommendation, the details are open to criticism, and Governor Glynn, when interviewed concerning it, promptly characterized it as an impossible dream. It would probably be difficult to find men of the requisite ability and business standing who would be able and willing to devote the necessary time to the work without compensation. Furthermore, a board of eight members is large enough to be unwieldy. Even with an ideally competent Executive in charge of the entire work, there would still be questions of general policy coming up all the time, with which the Board itself would have to deal, so that service on such a Board would be very much more than an empty honor involving only perfunctory duties.

Membership on this board, moreover, would be practically confined to men of wealth, able to spare the necessary time for the work, or else to men of advanced years whose time was worth little. That is not good material from which to construct a body which has as one important part of its duties to act as a bomb-proof shield between the engineers who are carrying on the State's work and the powerful political machines.

There would be, of course, no necessity of paying the members of such a highway commission [illegible] large salaries as are paid to the members of the [illegible] Service Commission, for example, who devote all [illegible] time to their work. Enough compensation should [illegible] allowed, however, to make it possible for active and [illegible]mpetent business or professional men to accept appo[illegible]ment on such a commission even if not possessed of [illegible]pendent means.

As noted above, however, Governor Glynn [illegible] is apparently not been favorably impressed with M[illegible]sborne's recommendation. The Governor's plan, apparently, is to appoint a board of advisory engineers, to coöperate with the Highway Commission, and he has announced General W. T. Rossell, late of the Corps of Engineers, U. S. A., as the first member. No one will question that a board of advisory engineers, as an aid to a competent and honest executive, may serve a very valuable purpose. But as a safeguard against political control and fraud, a Board of advisory engineers is about as much of a protection as a tin shield would be against the fire of a gatling gun.

Electrical Sterilization of Milk

Numerous reports and occasional inquiries continue to come to us about processes for the sterilization of milk by the direct action of electric current. One such process seems to be on the verge of a commercial trial in Liverpool, England, and another scheme may be expected to be launched as a commercial venture at any near time in this country. A few words, therefor, as to present knowledge of the effects of electric-sent currents through milk may have more than passing interest.

First, there is authentic evidence that under certain conditions milk can be thus sterilized, or at least "disinfected," and this apparently without the modification which accompanies pasteurization. The electric currents employed necessarily are either continuous or alternating. The gross effects may be similar but the actions must be different. In the first case any effect is probably largely electrolytic, and in the second case largely thermal, for in all fields of application alternating-current electrolytic effects have been found slight and due to secondary reactions that intervene between the reversals of current. If the action of alternating currents on milk is due to the developmnt of heat energy within the liquid, it is not self-evident why there should not be the same modification of natural character as when the heat is applied externally, in pasteurization, with a greater or less temperature gradient from the exterior. The amount of heat liberated in alternating-current sterilization trials has seemed too small and the thermometers temperatures have seemed too low (viewed in the light of experience with pasteurization) to explain the results secured. Possibly there is some slight secondary electrolytic action superimposed on the thermal. Therefore, sterilization by the passage of alternating current is apparently an effect which we can only note without securing an explanation from the meager data now available.

When direct current is passed between insoluble electrodes apparently there is an obscure development of compounds like hydrogen peroxide—at least it is reported that the sterilized milk responds to tests applied to milk treated with peroxide. There is reported in this direct-current treatment a similar after effect also; that is, the

milk may take on an offensive smell while practically sterile, due perhaps to the oxidation of albuminoids. Under what conditions this occurs and how it can be avoided with the electrolytic process only careful study will disclose.

From the foregoing there is seen to be a notable similarity between the sterilization schemes for milk and for water. In the latter case, there is the electrolytic production of disinfectants or coagulants which act just as though they had been mechanically introduced. In the process for milk there is the probable production of an obscure disinfectant (neglecting the thermal action) which acts like injected hydrogen peroxide.

We should emphasize again here what we have pointed out in earlier comments on sterilization of water and sewage (see ENGINEERING NEWS, Mar. 21, 1912) that it seems an idle dream to think of "electrocuting" bacteria in a liquid—as idle as to propose to kill the bathers at Coney Island by sending current at any voltage between Boston and Philadelphia via the Atlantic Ocean.

Government Ownership of Telegraph and Telephone Lines

Is the United States likely to take over the telegraph and the telephone business? Heretofore discussion of this question has been largely academic. Whatever public sentiment there may have been in favor of such a change in governmental policy, it has never found much support either in Congress or in the Executive Department.

Nearly a quarter of a century ago, John Wanamaker, when Postmaster General, strongly urged the taking over of both the telegraph and the telephone business by the government. There was at that time no greater evidence of public support for the proposition than there was for the policy of government ownership of railways when it was advocated by William J. Bryan some years ago, after returning from his trip around the world.

Indications are strong, however, that at the present time both Congress and the Executive are strongly disposed in favor of the policy of government ownership. The recent passage, practically without opposition, of the bill for a government railway in Alaska is one of the straws which shows the direction in which the wind is blowing. Now comes a report to the Postmaster General by a special committee of the Post Office Department, composed of the First Assistant Postmaster General, Daniel C. Roper, Chief Clerk, M. O. Chance, and Superintendent of the Salary Division, J. C. Coombs. This report, which was dated Nov. 25 last, and has just been made public, concludes with the recommendations that Congress should declare that all telegraph, telephone and radial communication with any other means of transmitting intelligence that may hereafter develop is a government monopoly. It is further recommended that the Government should purchase at an appraised value the entire commercial telephone network, except the farmer lines, and should then issue revokable licenses for the operation by private individuals and corporations of such parts of the telephone and telegraph service as are not acquired by the government.

While the Executive Department has not formally approved the policy thus laid down, Postmaster-General Burleson in his annual report makes a strong argument in favor of government ownership of both the telegraph and telephone lines, and urges that the Post Office Department should have control over all means of the communication of intelligence.

It may freely be admitted that the argument in favor of government ownership of the telephone and telegraph is in many respects very strong. It is true that the United States is the only great nation of the world which still leaves these great natural monopolies to be carried on by private enterprise. It may even be granted that if the situation of these monopolies were that which existed twenty years ago or even a dozen years ago, the argument in favor of government ownership might be convincing. Since that time, however, great strides have been made in the way of bringing these private enterprises under public control. Through the Interstate Commerce Commission and other national bodies likely to be established, and the State public-utility commissions, all the operations of both telephone and telegraph companies are now under strict government supervision both as to the service which must be rendered and the rate which may be charged.

It may freely be admitted also that the conduct of the Western Union Telegraph Co., during the years when it was practically moribund prior to its taking over by the Telephone company, furnishes good ground for the claims of those who argue in favor of government ownership. But when one turns to the telephone business and compares the telephone service furnished in American cities with the service furnished under Government administration of the telephone business in foreign countries, it would require very strong arguments to convince one that a change from the American system for the sake of imitating foreign countries would be advisable.

But the contrast between the character of the telephone service here and abroad is by no means the strongest argument against government assumption of the telegraph and telephone business. If there were any likelihood that when the United States government undertook the operation of the telegraph and telephone, it would conduct the business as efficiently and economically as it is conducted in England or in Germany or in Norway, business men and the public generally might very likely conclude that while the change was to be deprecated, it was not worth expending much energy to oppose. But is it probable that any such efficiency and economy would be obtained by our government as it is at present constituted?

The public, which looks only at the surface, may think that the Post Office is carried on efficiently and economically; but those who are familiar with the inside of governmental business, well know the vast difficulties in carrying on government work as it should be carried on to produce economical results. What more authoritative witness could be called to testify on this subject than President Wilson himself? In a heart to heart talk before the Washington Press Club, on Mar. 17, President Wilson said:

> **The various parts of this continent are becoming painfully suggestive to me. The post offices and many other things which stir reminiscence "are sicklied o'er with a pale cast of thought." There are post offices to which I wouldn't think of mailing a letter—which I can't think of without trembling with the knowledge of all the heartburnings and the struggle there was in connection with getting somebody installed as postmaster.**

Does not this frank statement reveal at a glance one of the deep-rooted difficulties in the establishment of anything like economy and efficiency in the conduct of our governmental affairs? President Wilson was elected to office avowedly as a statesman, and not as a politician. Yet custom and precedent and force of circumstances compel him to consider local politics and local political squabbles in selecting the men to carry on the postal business of the country.

Would one expect to find efficiency in the American Telephone Co. if President Vail had to personally consider the selection of the local superintendents in charge of the business of the company in cities scattered from the Atlantic to the Pacific? Suppose he had to consider not merely the fitness of these men for appointment, but what were their local political affiliations, what service were they rendering to this, or that or the other party machine or machine-smashing organizations. We need go no further afield than the indictment of the work on New York State highways, made by Mr. Osborne in this issue of ENGINEERING NEWS, to see where such political control leads us. Or, if one wishes an example from the national government, just inquire with what regard to the public interests our State Department is now being conducted.

Every successful private corporation knows that success under modern competitive conditions depends first of all on putting able men in charge of the administration of the concern, and keeping these men continuously in service under such terms as make it worth their while to remain. But in what departments of the national government does distinguished ability receive due recognition in the way of promotion and permanence of position? Notwithstanding all that has been done in the way of Civil Service laws and regulations, the public still holds the opinion that appointment to public office is a perquisite of the political party in power. The public approves paying high wages to laborers and clerks. It has never fully understood the idea that an official in high authority, who is paid $10,000 or $20,000 a year, may by his ability save five or ten times that amount in the expenditures which are under his control, or if incompetent may cause equal or greater waste and loss.

The question whether we are to have government ownership of telephone and telegraph lines in the United States in the near future depends, probably more than anything else on the expression of public opinion. If a great flood of petitions from various organizations sweeps down upon Congress, urging that the telephone and telegraph lines be taken over by the government, the thing is very likely to be done in short order. On the other hand, if pressure is exerted upon Congress and the Executive, from business men's organizations, chambers of commerce, boards of trade, engineers' clubs and societies, opposing such an extension of the government business and presenting the strong arguments against it, the danger is likely to be averted.

We believe this is a matter in which engineers should be especially interested. More than any other class of men, probably, they have the experience and the detail knowledge necessary to consider this question intelligently. Very many of them know from experience the great handicaps with which government engineering work is carried on, and the extent to which engineers' services under the government fail of proper appreciation and reward. There seems to be here both a duty and an opportunity for the engineering profession.

Letters to the Editor

English and Metric Scales

Sir—All engineers who have to work in the United States and Great Britain and her colonies, and in continental countries and all lands south of the Rio Grande, have reason to thank Mr. H. P. Quick for the lucid comparison of English and metric measures, which he gives in ENGINEERING NEWS, Mar. 12, and especially for the insert sheet of conversions. No one should be without it.

The writer, having a great deal to do with the countries above mentioned, found it to be quite necessary to have general flat scales showing, by proportion, metric on one edge and English on the other as one has, on a Chesterman pocket steel tape, feet and inches on one side and decimals of a meter on the other. The scales needed could not be found so that the writer had them made for him under his direction by the Keuffel & Esser Co. They were divided 1 : 1000 feet one side and 1 : 1000 meters the other side; -: 2000,—1 : 2500,—1 : 3000,—1 : 4000,—1 : 5000. They are flat scales with white edges, and of course with them one can use 1 : 10,—1 : 100,—1 : 1000,—1 : 10,000,—1 : 100,000, etc., and the same with the other proportions.

These have been put in a neat box with the numbers of the scales marked on the left of the box. The writer could not get along without this set and he takes it with him always in going back and forth between this and other countries. It helps out until the time comes when the unscientific and confusing English measures are abandoned and we have a more comfortable kind to use.

E. L. CORTHELL.

149 B'way, New York City, Mar. 16, 1914.

Present Braking-Force Allowances in Bridge Design are Sufficient

Sir—Referring to the editorial in your issue of Feb. 19, under the caption, "A Higher Value Necessary for Brake Retardation in Railway Bridge Design," is it not a fact that the Pennsylvania R.R. brake tests, which seem to furnish the principal data for your article, were made with fast passenger trains only? The typical train mentioned in the summary of results of these tests, published in the same issue of ENGINEERING NEWS, "weighs nearly 1000 tons" and "is about 1000 ft. long," which is about 2000 lb. per linear foot of track.

In Bulletin No. 161, of the American Railway Engineering Association, J. E. Greiner has tabulated the practice of 39 roads as to rolling loads on bridges as follows:

No. of roads	Mileage	Practice indicated from specification or proposed loading	Loading per foot of following train
1	3,228	Considers E65 insufficient	6500 lb.
13	45,750	Consider E60 sufficient	6000 lb.
15	93,773	Consider E55 sufficient	5500 lb.
10	49,392	Consider E50 sufficient	5000 lb.
39	202,143	Average = E55	5500 lb.

The above specification loadings are, of course, intended to provide for the heaviest slow freight trains. The longitudinal force at the rail which could be directly deduced from such loadings would, in almost any conceivable case except such as accidental collision, be at least twice that caused by any existing or proposed passenger train even when equipped with clasp brakes electrically controlled.

Some six or seven years ago, the writer was called upon to design a number of first-class railway bridges and viaducts, two of the latter being of a considerable height and on curved alignment. The specifications were for E50 loading with the requirements of 25% for the coefficient of brake-drag and an allowance for impact of 50% of the longitudinal force. The stresses computed on that basis were so large that, if not unmanageable, they appeared unreasonable. Not wishing to waste the railway company's money by complying with an obviously defective theory, the writer consulted the eminent motive-power authority, George R. Henderson, and obtained the following practical data: Coefficient of brake-drag, 30%. To avoid skidding (except on very bad rail) brakes are adjusted so as to develop a maximum braking force of not more than 30% of the following percentages of the wheel loads: Engine drivers, 90%; light weight of tender, 70%; light weight of cars, 70%.

Mr. Henderson also mentioned the following figures as representing practical braking forces:

Longitudinal force at the rail: 20% of total weight of engine; 25% of light weight of tender; 300 lb. per lineal foot of following load per track, or 8000 lb. per car.

These figures were considered perfectly safe, and they were adopted in the following form. Total braking force for bridge design: 30% of 90% of weight on engine drivers; 30% of 70% of light weight of tender; 300 lb. per lineal foot of following train. Add 50% for impact or dynamic effect. These allowances have been used in the design of 20,000 to 30,000 tons of bridgework for several railways.

For a 1000-ft. train of the typical loading used for the design, the allowances just stated give a longitudinal force at the rail of about 394,000 lb. plus 197,000 lb. for impact, or a total of 591,000 lb.

Comparing with the preceding the 1000-ft., 1000-ton passenger train of the Pennsylvania brake tests, assume that it is made up with a 2-6-2 locomotive, having 115 tons on 33-ft. wheelbase, 90 tons on 13-ft. driving wheelbase, and a tender weighing 60 tons loaded and 30 tons light, on 25-ft. wheelbase (total wheelbase of engine and tender, 53 ft., giving about 58-ft. length from center of pony truck to end of drawbar), and following cars to make up the total length and weight. Then computing 30% of 90% of driver weight, 30% of 70% of tender (light) and cars, the total braking force is 408,000 lb. This is only 3½% more than the allowance the writer has been using for a number of years based on Henderson's coefficients, and with the allowance for impact added it is exceeded by 45%.

If these comparisons are correct, as the writer believes, there is nothing in the Pennsylvania R.R. brake tests either to cause any uneasiness concerning existing bridges or to require any increase in the allowance that competent designers have been using. In fact, it is probable that some designers, who have been using 20% to 25% of the total weight of typical train, will find they can very materially reduce their allowance with perfect safety and effect considerable economies, especially in trestle towers.

The case of some old bridges is quite different. Many structures were built 20 to 30 years ago without any provision for horizontal forces except wind. The writer reviewed and replaced some old iron viaducts several years ago which had little or no longitudinal bracing, one of which was on a 4° 15′ curve near the bottom of a steep grade. The bents were on a skew of 35°, and only had a width (longitudinal to the track) of 4 ft. 6 in. There was nothing whatever to resist longitudinal and centrifugal forces except the wooden floor and rails and yet it had stood up and carried the traffic for many years.

The only possible explanation in this case is that the rails and bond or guard timbers acted as horizontal chains around the curve. Certainly no one would use this, or any number of similar examples, to justify dependence on the rails and bond timbers for the safety of structures, but it seems reasonable to take them into account in criticizing very excessive allowances for the longitudinal forces. In other words, they may properly be considered in fixing safety-factors for future increase in rolling loads, as indeterminate factors on the side of safety, provided always that the structure would be in stability without them.

A. W. Buel.

15 William St., New York, Mar. 6, 1914.

The Twisting Strength of Various Shapes; Torsional Failure in the Orpheum Collapse

Sir—Nothing is more instructive to the engineer than the study of the failure of an engineering structure, and an investigation into the causes that contribute to such failure. This is especially so in the case of the collapse of the Orpheum Theater under the mysterious circumstances outlined in Engineering News of Jan. 1, 1914. The fact that no fewer than three different theories were advanced to explain the failure makes it all the more interesting. This fact gives the writer his excuse for again opening up the subject in the hope that his explanation may add to the interest of the discussion.

The Torsional Strength of Beams of Commercial Section—It is not generally known that all beam sections commonly used in practice are considerably weaker in torsion than one would be led to predict from a mathematical calculation based on the ordinary torsional formulas. It has been the writer's privilege to carry out a number of experiments in the Engineering Department

of University College, Dundee, on the torsion of beams of commercial section. A full description of these tests need not be given here, but a short resumé of the results obtained may be permitted. The interested reader will shortly find a full description of the above in *Engineering*.

As before pointed out, the actual torsional strength of a beam other than circular in section is very much less than the theoretical torsional strength.

If the ordinary torsional formula be written in the form

$$CJ = K\frac{TL}{\theta}$$

Where

C = the modulus of rigidity, lb. and in.;
J = polar moment of inertia, lb. and in.;
T = twisting moment, in.-lb.;
L = length, in.;
θ = angle of twist, radians; and
K = empirical constant;

the value of K for the various sections was found to be

Type of beam	I section	Channel	Angle	Tee
Value of K.....	0.01	0 03	0.105	0 09

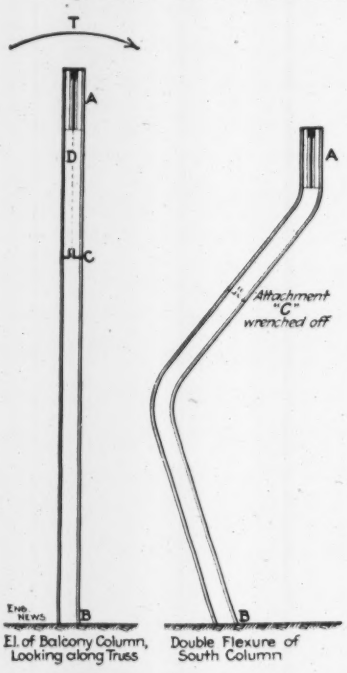
A number of solid rectangular and hollow rectangular sections were also tested, from which the following table was deduced, where the values of K apply to both solid and hollow sections.

Ratio $\frac{\text{Greatest Side}}{\text{Least side}}$	1	2	4	6	8	10
Value of K.....	0 843	0 548	0.198	0.097	0.566	0.037

A glance at the above results is sufficient to show that errors of enormous magnitude are inevitable if the ordinary torsional formula is adhered to. The reason for the great discrepancy between the actual and theoretical values cannot be dealt with here, but readers are referred to the above paper for a complete explanation. It may be stated, however, that the above tests indicate that the only efficient part of an I-section is the small element of section at the junction of the flange and web, and that as a result the torsional shearing stress becomes very great in this neighborhood.

The Failure of the Orpheum Theater—In the case of the Orpheum Theater, it will be at once realized that no weaker type of construction could possibly have been chosen to support the balcony than the balcony truss adopted. The truss in question is built in the form of an open-web I-section girder of great height compared with its breadth, and, moreover, all the conditions necessary for the production of a twisting moment are here present. A rough calculation indicates that the theoretical polar moment of inertia of the section of the balcony truss equals 180,000 inch^4 units, while the actual value becomes, on the application of the above empirical constant, 1800 inch^4 units. In all probability, the effective polar moment of inertia would be considerably less than this, as some indication was given in the above tests that a dimensional effect influenced the experimental constant. The greater the ratio of depth to breadth, the more inefficient does the section become. The concrete casing surrounding the girder would undoubtedly increase the torsional rigidity of the girder, but even then, as indicated above, a solid rectangular beam approximately 10 ft. by 1 ft. would only generate about 4% of its theoretical torsional strength, and moreover, it is highly probable that the girder itself was considerably twisted before the concrete was applied.

Many of the observations made in the various reports strongly suggest that the cause of the failure was the incipient weakness in torsion of the balcony truss. In the first place, the deflection at the ends of the cantilevers was excessive, amounting to about 3 in., which involves a twisting of the balcony truss such that the bottom flange would have been displaced backward by about 1¾ in. Again, it was noticed that the bottom-chord attachment to the south balcony column was wrenched off, and furthermore that the half of the truss nearest this column fell vertically, suggesting that the attachment gave way before the general collapse and indeed was the initial cause of failure. Now, had the truss been subjected to a twisting moment, this torque would have been transmitted to the columns through the attachments of the top and bottom chords, the attachments being subjected thereby to a shearing force in the plane of the flanges of the column. It has already been indicated that under such circumstances the stress would be almost wholly concentrated at the junction of the flange and web, the greater part of the flanges offering little, if any, resistance to torsion. To put it in slightly modified form, the whole shearing stress at the attachment to the column would be borne by the rivets immediately in the neighborhood of the junction of flange and web. It is highly probable then that under these circumstances rupture of the rivets took place by shearing. If shearing at the attachments did take place, then since the attachment of the top chord is very much heavier than that of the bottom chord, the latter would give way sooner than the former.



Suppose we briefly consider the equilibrium of the south balcony column and truss, under the action of a twisting moment. Let AB (see sketch) represent the balcony column and A and C the attachments of the balcony truss. Suppose the truss were subjected to a twisting moment about point D and in the direction indicated by T, this twisting moment being resisted by the attachments at A and C.

If the twisting moment were such as to exceed the shearing strength of the material, attachment C would first give way as pointed out before, and in consequence not only would the twisting moment be increased in the direction of the arrow, but the axis of twist would be transferred to a point nearer the top of the column, the

result in increase in bending moment causing the column to buckle. In falling the truss would tend to remain vertical because of its attachment to the north column, and also due to its being braced by the cantilevers. Because of the fairly substantial nature of the attachment at A, this would produce a bending moment on the column of opposite sign to that which initially caused buckling. This would account for the double flexure of the column, and also for the breaking away of the bottom chords of the center and south cantilevers. Furthermore, since the twisting moment is now almost unopposed, a bending moment would be applied to the north column and cause this to buckle also. In this case, however, the truss attachments did not give way, and no double flexure was produced.

The subsequent course of events is then easy to follow. The *fascia* girder was pulled backward, buckling the roof columns at the attachments. The weight of the roof then buckled the roof columns at the attachment of the proscenium struts which latter pivoted round their built-in ends. The roof fell in, and the collapse was complete. The application of a torque to the balcony truss would also tend to produce a twisting moment on the roof columns due to the eccentric connection of the *fascia* girder. That such a twisting moment actually did come upon the roof columns is amply evidenced by an inspection of the photographs reproduced in ENGINEERING NEWS. The rupture of the bottom chord of the balcony truss was probably due to the fall of the roof.

The above explanation seems fairly complete, and indicates that had the balcony truss failed under the application of a twisting moment the various phenomena noticed would have followed as a natural sequence.

Had a box girder of nearly square section been adopted to support the balcony it would have been much less affected by a twisting moment, the square section developing as it does about 84% of its theoretical torsional strength. If such a girder had been used, the structure would undoubtedly have remained secure. A much neater and better type of construction, however, would have been a circular arc girder firmly anchored at the abutments. Such a girder is somewhat difficult of design, since at each section throughout its length both bending and twisting moments are in evidence. The whole problem of the equilibrium of such a girder has, however, been considerably simplified,* so much so in fact that the problem can be tackled almost as easily as that of the ordinary straight fixed-end beam.

The writer would be indebted to anyone, however, who might be able to point out any flaw in the above reasoning.

ERNEST G. RITCHIE.

University College, Dundee, Scotland.

[The noteworthy experiments above cited point to very low torsional stiffness of most of the customary shapes. But such low stiffness, or torsional flexibility, would permit the balcony truss to yield to the deflection of the cantilevers without transmitting a very great twisting moment to the balcony truss columns. Looking at it another way, the bottom chord of the truss was a horizontal beam between the columns, and this beam was deflected about 2 in. near its middle. Could this deflection exert great enough reactions against the columns to buckle them? We doubt it.

Shearing or wrenching off of the bottom-chord attachment at the south column would relieve the twist stresses. The destructive actions would doubtless then stop, as the top of the column was held laterally by the balcony slab concrete, and the truss still had its full vertical strength. —EDITOR.]

*"The Equilibrium of the Circular Arc Bow-Girder," Prof. A. H. Gibson, Trans. Roy. Soc. of Edinburgh, Vol. XLVIII, Part II, No. 20.

Recuperating from Floods in Southern California

Sir—Of interest to the engineering profession at the present time is the damage caused by the recent floods in southern California, and the steps which will be taken to repair and reconstruct.

The structures most seriously damaged were of a temporary nature, constructed in many cases on wood trestles, the bents spaced about 15 ft. c. to c.; the floodwater carried with it a large amount of débris, which accumulated between the bents, practically forming a dam, which resulted in a washout.

In other cases, where the bridges damaged were of a more permanent nature, the failures were caused by the undermining of piers or abutments, due in the first place to not providing sufficient waterway for a storm of the proportions of the recent cloudbursts, and due in the second place to the foundations not extending to a sufficient depth to prevent the erosion caused at such points by the velocity of the flow.

The soil in this section of the country is different from that in the Eastern states. Along the Los Angeles River, earlier floods widened the river bed in many places, leaving vertical banks 20 to 30 ft. in height. These banks while dry, are very substantial; but the soil in contact with water becomes quick and is easily scoured.

This condition makes it necessary that the upstream side of all bridges should have suitable protection for the adjoining banks for a sufficient distance to prevent the washing out of the approaches to the bridges, as occurred in a number of cases in the recent storm.

The damage to structures and roads is of such an extensive nature that it will be some time before travel will be restored to a normal condition. The railways have made records in restoring travel over their lines by repairs of a temporary nature and will probably continue improving the roadbeds with permanent structures. The flooded counties have before them the proposition of opening up the highways in a temporary way by constructing detours through the riverbed where the water has receded, rebuilding the temporary type of structures that existed before the flood, or building permanent structures which will provide for all the conditions that a study of the results of this record-breaking storm may bring forth.

There is considerable controversy over the issuance of bonds for the building of concrete bridges to replace the damaged structures; but it is generally conceded that concrete bridges will be built. There was a discussion at the City Hall on Feb. 22 in connection with a bond issue of $250,000 for replacing with concrete bridges, the structures washed out on the Arroyo Seco River.

The Los Angeles River carried a large amount of silt into the channels of the Los Angeles harbor, which is estimated will cost about $75,000 to remove.

M. AM. SOC. C. E.

Los Angeles, Calif., Mar. 5, 1914.

An Alluring but Light-Weight Contract Clause

Sir—In submitting propositions for the engineering work in connection with municipal improvements, my attention was called to a clause inserted by an Oklahoma engineer in his contract. In the clause, which follows, the first party was the city, and the second party was the engineer.

In case the second party shall thus be employed to inspect the construction of the work, which employment shall be optional with the first party, then the second party agrees to protect the first party against all losses due to engineering mistakes, negligence or carelessness of the second party, and further guarantees that the actual cost of construction will not exceed the estimated cost thereof as submitted by the second party; and second party further agrees that before actual construction begins second party will file with the first party a good and satisfactory bond in the sum of 20% of the estimated cost of the work, guaranteeing that every obligation of the second party hereto will be fulfilled, such bond becoming void only when the first party shall knowingly and willfully violate the maps, plans, specifications and instructions of the second party in the construction of the work.

This clause in an engineering proposition never fails to attract the officials, and it is usually explained by the party submitting this kind of a proposition that with this clause in the contract they can be absolutely protected from any *engineering mistakes,* etc., which might otherwise cause them the loss of hundreds or thousands of dollars. The writer would like to know what the engineering profession thinks of a clause of this kind in an engineering contract.

Certainly it is no more reasonable to expect that an engineer shall put up a bond guaranteeing that he will not make a mistake than to expect a lawyer to furnish a bond guaranteeing that he will not make a mistake in defending a case, or in the interpretation of the law. Neither would it be more reasonable to expect a physician to give one of his patients a bond guaranteeing physical ailment.

If municipalities would properly investigate engineers who submit propositions, they would not have things occur which would necessitate the giving of bonds guaranteeing "engineering mistakes."

An engineer's reputation is his stock in trade. If he makes a mistake, it reacts against him on other work and every conscientious engineer knows this; besides, engineering is the theory of economy and a profession of accuracy.

W. L. BENHAM.

Oklahoma City, Okla., Mar. 5, 1914.

[This subject was discussed editorially in our issue of June 5, 1913, on p. 1185, and commented upon by letters in ENGINEERING NEWS, of July 10 and 24, 1913, pp. 85 and 178.—ED.]

On the Recently Defeated Amendments to the Constitution of the Am. Soc. C. E.

Sir—The reasons for the defeat of the constitutional amendments of the American Society of Civil Engineers, advanced in your editorial columns, of Mar. 12, may be true. In fact, a number of reasons could easily be given with equal probability. And should the membership accept your implied invitation to contribute a "concrete expression" as to their reasons for voting, would it not be first and last just "interesting"? It would be gainful to know how the vote was distributed geographically; how the resident membership stood, and con, if that is possible.

As a member of the Society, I commend your generosity in opening your columns to the membership. I hope a generous response will show appreciation of the opportunity thus presented. It is for the professional practice to make the advances, leaving to the journalist the duty of observing and interpreting.

It is particularly regrettable that the structure of the Society provides the necessary machinery, neither for forming nor for guiding a progressive constructive policy or opinion. Such an opinion is slow of formation and clumsy in grappling with practical problems, and the offer made by you shows at once the lack, and the necessity for meeting this.

A widely scattered membership lacks the opportunity to "get together." The business session at the annual meeting provides neither the time nor satisfactory conditions nor surroundings for those who would start progress. The proceedings are audible only to those in the immediate vicinity of the chair; fully two-thirds manifestly may take no part. This does not induce to the advancement of the profession.

If your statement, that these amendments are "merely means to an end," be true, no more time should be wasted in trying to pass constitutional amendments; for, as you rightly say, their defeat loses a large part of its importance, considering the means at hand for correcting evils.

Article VIII—Section 5,* provides such a means. It is only a step to be sure, but it is scarcely creditable that the Board of Direction would fail to recognize a well expressed desire on the part of those participating for an extensive and intensive use of the activities of the Society.

There are many such possible activities. Other national engineering bodies are making satisfactory advances; local branches of this Society are doing likewise. Failure of the parent Society to meet this demand in the past is now apparent.

For the personal and careful consideration of those who oppose any action looking to this end, I quote the following lines of James Russell Lowell:

> New times demand new measures and new men;
> The world advances and in time outgrows
> The laws that in our fathers' day were best;
> And, doubtless, after us some purer scheme
> Will be shaped out by wiser men than we,
> Made wiser by the steady growth of truth.
> The time is ripe, and rotten-ripe, for change;
> Then let it come; I have no dread of what
> Is called for by the instinct of mankind.
> Nor think I that God's world would fall apart
> Because we tear a parchment more or less;
> Truth is eternal but her effluence,
> With endless change, is fitted to the hour;
> Her mirror is turned forward, to reflect
> The promise of the future, not the past.

J. BODINE WRIGHT,
Consulting Engineer.

New York City, Mar. 16, 1914.

*Article VIII—Sec. 5: Special meetings may be called by the Board of Direction, and shall be so called on the request of thirty corporate members, which request shall state the purpose of such meeting. The call for such meeting shall be issued ten days in advance, and shall state the purpose thereof, and no other business shall be taken up at such meeting. At these meetings thirty corporate members shall constitute a quorum.

The Pay of Young Engineers at Panama

Sir—In your issue of Feb. 26, I note E. A. V., Jr.'s, letter. I pray why go to Panama to have one's feelings ruffled? I have found such conditions in every great engineering organization. Luckily, I have, incidental to acquiring 10 years' experience, developed a less turbulent disposition than E. A. V., Jr. However, my feelings become aggravated by such a careless statement of facts as he is guilty of. It may lead to a new Panama scandal.

The Isthmian Canal Commission pays, to quote his statement, "college graduates from civil, mechanical and electrical courses of four years, from $125 to $250 per month." From this, one may receive the impression of extreme extravagance, because "college graduate" is a term usually applied to men green from those four-year courses. Such men were employed on the canal at an initial salary of $100—plus or minus. The $125 and over was for men with experience. Even at $100, these green men received 100% more than they ordinarily start with in the States.

I also object to the "to $250"; of course, I say myself "$125 and over," but I would not libel the I. C. C. by generalizing "to $250."

Also, if a clerk outranks an engineer he *should* receive a higher salary, as in one case I have in mind. In the Atlantic Division, the order of the officials was Division Engineer, Office Engineer, Chief Clerk, File Clerk, Chief Draftsman.

I hope the above will absolve the I. C. C. from having violated established practice relating to engineers' salaries and particularly those of college men green after four years' study.

Now permit me to become reminiscent concerning one of those little incidents which become well fixed in the mind. In quarters with one of the steam-shovel men (initial wages $210 per month) the fellow presumed to become familiar. He had the audacity to give *me*, an engineer with two degrees and once honored by Associate Membership in the Am. Soc. C. E., this conundrum: "Do you know why the I. C. C. pays you fellows $125 and $150?" Perplexed to the point of forgetting my dignity, I asked for the answer and it came: "Because they are ashamed to pay you less!"

C. E.

New York, Feb. 28, 1913.

Sir—The letter in your issue of Feb. 26, signed E. A. V., Jr., on the "Comparison of Salaries of Instrument Men and Clerks," gives the impression that the inexperienced college graduates of engineering schools were underpaid on the Panama Canal work, although they received from $125 to $250 per month.

It has been my experience that engineers and men in other lines of work are usually on "opposite sides of the fence" as regards each other's relative importance. I am an engineer but I like to see fair comparison drawn.

The tendency, it seems to me, is for engineers to consider that inasmuch as they have graduated from a technical school and seen some service, they are a little better than the men who have "just worked."

They forget that it is energy, perseverance and determination as well as education that is necessary and that men may make themselves valuable without the education of a technical school if they have the other requisites.

The men who work in other departments than engineering, for the government and in private enterprises, have usually been fitted for their positions by as much hard work as the engineer or more. The clerks and other office men handle the income and expenditure of the organization amounting to thousands of dollars and are specially competent for the work. Expert steam-shovel operators and construction foremen are also the result of strenuous experience. Your correspondent should not feel that rodmen are underpaid if they receive less than the other men above mentioned. The rodman is paid for doing elementary engineering work regardless of his education.

E. A. V., Jr., would probably be surprised to find that he could not successfully do the work of the office men, clerks and others of whom he speaks, without years of special training perhaps as difficult as his own particular training.

When engineers, as a class, realize that there are men fully as good in commercial and other lines of work, we may expect to find more harmony among departments on some of our big work and as a result a wonderfully increased efficiency as a whole.

H. M. C.

San Francisco, Calif., Mar. 6, 1914.

NOTES AND QUERIES

In the article entitled "Temperature Measurements in a Concrete Building," March 19, 1914, the words "Roof" and "Base" in the table on p. 606 should be interchanged. That is, the distance between plugs at the roof decreased in length 0.060 ft. and that at the base decreased 0.007 ft.

Apropos of the recent discussion in these columns on the relation between the stresses in a structure and the stresses in a small-scale model of the structure, J. V. Nemino, of Vancouver, B. C., calls attention to a paper by Prof. Archibald Barr, who recently retired from the class of Engineering at Glasgow University. Prof. Barr's paper was read in 1899 before the Society of Engineers and Shipbuilders of Scotland and was entitled "Comparison of Similar Structures and Machines." It explained very clearly the principles on which such comparisons could be safely made.

We have received the following letter:

Gretna Fla
Mar 19—1914
The Editor Engineering News. dear Sir pleas give me full infomation and price complete a bout magic dips and Spanish Compas needles that finds Silver when it is burried I am interested in this and I.ll be too glad to secure one at once a waiting your answer I am truely

Wisdom Martin.

The trade directories in our reference library are seriously deficient in failing to list dealers in the instruments Mr. Martin desires. We must also confess our own uncertainty as to whether "Magic Dips" should be searched for under "Dancing, Teachers of," or under "Candles." As for the "Spanish compass needles that finds buried silver," we presume valuable advice might be obtained from the "Constitutionalist" generals in Mexico.

The Last Turnpike or Toll Road in New England, or what is believed to be the last one, has recently been abolished. This is six miles of macadam road in the towns of Peru and Winhall, Vt. For years local protests were unavailing in freeing the turnpike of its toll gates, but when the road became an important link in a popular automobile route through the Green Mountains the protest brought about state action, and the toll gates have now been removed and the road made free. It is only within the last four years that toll roads have been abolished in Maryland and Pennsylvania. The first American turnpike, it is said, was the famous one between Philadelphia and Lancaster, the company for which was chartered in 1792.

Governor Glynn's Investigation of New York State Highway Work

The investigation of contract work on New York State highways has been a very active industry during the past year. The investigation began under Gov. Sulzer when the road work was taken from the control of the commission into whose hands it was during Gov. Dix's administration and placed under Commissioner John N. Carlisle. Gov. Sulzer's chief highway investigator, John A. Hennessy, gave wide publicity to the results of his work in speeches during the political campaign of last fall. Mr. Hennessy's charges resulted in a long inquiry by District Attorney Whitman, of New York, in an investigation just started by the New York legislature and in the appointment by Gov. Glynn, of Jas. W. Osborne, a prominent attorney of New York City, as a special commissioner of investigation.

A preliminary report was made by Commissioner Osborne to Gov. Glynn last week. We print the main portions of it as follows:

In the year 1912 contracts were let for the maintenance and repair of about 400 state highways. Of these a large number were examined by expert engineers and in almost every case, it was found that the work had been so done as to result in substantially a total loss to the state. The specifications were not followed in respect to the size or quality of the stones to be used. The prices charged for the stone were exorbitant. In my judgment, the amount of money lost by the state in the maintenance and repair of roads during the year 1912 will amount to more than a million dollars.

I find that the three State Highway commissioners totally neglected their duty in respect to road maintenance and repair, and left the entire work to the First Deputy. Charles F. Foley, who was totally inexperienced in highway construction. The statute provides that the First Deputy shall have had practical experience in the actual building, construction and maintenance of highways. His experience consisted of a very short period of time as a day laborer on roads in his early youth, and while a member of the Board of Aldermen of the City of Lockport he was one of the members of the Committee on Streets.

The state provided the bituminous material for repairs and paid the exorbitant price of 7c. a gal. for its manipulation. This was 4c. a gal., on an average, more than was paid in construction work. In this maintenance work the temptation on the part of the contractor was to use as much oil as possible. In some instances, bituminous oil owned by the state was buried by the contractor. In other instances, barrels of it were abandoned by the wayside; and in other cases barrels of it were thrown over a precipice.

The inspection by the Highway Department of these maintenance contracts was totally inadequate, the inspectors being in many instances called from other work—barbering, tailoring, prize fighting, bartending, banking, baking, etc.

The present Highway Commissioner is a political appointee. His subordinates are political appointees, where his power is not circumscribed by Civil Service Regulations. The executive officers are political appointees. The Superintendents of Highways in each particular district are political appointees. The consequence is that if each one of these officers is to be useful to the politicians who caused the appointment, he must employ as many persons as possible at the highest possible wages. I find that the pay rolls of the department are uselessly padded. I find that the employees of the department have been compelled to pay contributions to political parties.

Contractors must be favored as much as possible in order to strengthen the organization in the respective districts. I find that the habit has prevailed for contractors to make large contributions to the State Committee, and to make large contributions to local committees. The consequence is that the contractor thus, in effect, by his influence, instead of being a servant, becomes the master. One of the frightful evils of this system is that the Civil Service employee who thoroughly does his duty, at once becomes a persona non grata. He becomes at once offensive to the contractor, and, therefore, offensive to his superior.

I find that efficient engineers who from time to time have found fault with the material furnished by the contractors and have criticized the manner in which their work was being done, have been either transferred or removed to remote districts from their families. Thus, inefficiency and dereliction on the part of the Civil Service employee becomes a virtue. I find that this evil existed under the three Highway Commissioners in Governor Dix's administration and has existed under the present administration. It is impossible to get under such a system good roads can be constructed.

I find that as a result of the various investigations which have been going on in the state, that the work of the Highway Department has very greatly improved; that contracts have of late been let with great financial advantage to the state.

The evils which prevail in regard to maintenance contracts, to a very large extent prevail in regard to construction contracts. I find that in many instances where the specifications have failed to be of advantage to the contractors, they have been changed or modified without public letting, so as to make the contract pay. This practice amounts to a total annihilation of the law regarding advertisements for bids, as the revised contract is practically a new contract. I find that this evil existed under the commission appointed by Governor Hughes, consisting of S. Percy Hooker, Robert Earl and T. Warren Allen, that it existed under the commission composed of John A. Bensel, Duncan W. Peck and C. Gordon Reel, and that it has existed under the administration of the present commissioner.

Under the system which has prevailed and which is now prevailing, the contractor by virtue of such political contributions, has an influence and power over the department which is contrary to the interest of the state. The appointment of the Highway Commissioner is dependent upon politics; the deputies, the executive officers, are appointed upon the recommendation of politicians. The superintendent of highways is appointed because of political, and not because of highway efficiency. The inspectors have been and can now be appointed as a matter of favor. Under this system, the state has absolutely no protection whatsoever. The state has provided $50,000,000 for highway construction, which has been expended without adequate results for the state. Millions of dollars have been expended in maintenance and repair, without adequate results; $50,000,000 more has been provided. It is absolutely essential that some means for the conservation and preservation of this fund should be provided. My recommendation is as follows:

That the state should act exactly as an individual would do who was going to provide a vast sum of money for charity. Such an individual, if he desired to create a charity to last perpetually, would appoint a board of trustees or commissioners to hold office during life, and upon the death of any one of them his place should be filled by the appointment of some worthy individual made by the President of the United States or the Governor, and these commissioners or trustees would appoint executive officers who, under rules and regulations approved of by them, would conduct the charity. I know of no other way in which a fund can be conserved.

I therefore recommend that a bill be enacted by the Legislature, providing for the creation of a bi- or tri-partisan board of highway commissioners to consist of representative citizens to be selected one from each of the eight judicial districts of the state, who shall serve the state without salary. This Board to be appointed by the Governor, and shall have the power of selecting an executive engineer who shall be the responsible executive head of the department with a salary sufficient to compensate and attract an engineer of eminence. The bill should provide for the appointment of an engineer who should be a civil engineer of the highest professional attainments, as well as possessing practical experience and executive capacity.

It seems to me advisable that the Board should be empowered to select the executive head of the department without regard to the place of his residence, whether it be within or without the state of New York. Moreover, the executive engineer should have absolute power of removal of all subordinates upon charges, subject only to the approval of the Board. With the exception of his secretary and secretary to the Board, every officer and employee of the department, including laborers, should be placed in a state civil service. Every position in the department should be made permanent and dependent upon merit.

I also recommend that it shall be made a misdemeanor for any contractor, or any person contemplating becoming a contractor for the state, to contribute to a state or local political campaign committee, or to any candidate. That it shall be a misdemeanor to accept any such contribution from any such contractor.

I also recommend the enactment of legislation making it a misdemeanor for any officer or employee of the Department

of Highways to contribute to any political campaign committee or candidate, and likewise making it a misdemeanor for any candidate or member of any political committee to receive any contribution from such officers or employees. It should be provided that no person should be excused from testifying as to such misdemeanors, but that immunity should be granted to the first person who discloses truthful information to the prosecuting authorities.

Governor Hughes apparently was so impressed with the necessity of taking the highways out of the politics that under his administration a commission was appointed partly Democratic and partly Republican, and I am forced to say that the work under that commission was on the whole better done, than under the succeeding partisan commission. The plan I have above suggested is carrying to its logical conclusion the thought that was evidently in the mind of Governor Hughes.

Sewage Disposal and Water-Supply at Chicago

An expenditure of $100,000,000 for sewage-disposal works, with annual charges which if capitalized would add the equivalent of another $100,000,000, will be necessary if the Federal courts enjoin the Chicago Sanitary District from diverting more than 4167 cu.ft. of water from Lake Michigan into the Drainage Canal. A possible alternative would be specific Congressional authorization to divert whatever amount of water the district needs, or can convince Congress it needs, to perfect its long-standing plan to dispose of the sewage of Chicago and vicinity by dilution. This and other interesting points, as set forth below, may be found in an interesting report by Langdon Pearse, division engineer, in charge Sanitary Division, the sanitary district of Chicago. Although the report was not made public until about Mar. 20 (in the printed *Journal* of the Sanitary District of Chicago, for Feb. 5, 1914), it was dated Jan. 29, 1914. The report is an answer to a report by John W. Alvord (consulting engineer, Chicago) and two other members of a committee of the Chicago Real Estate Board. The committee was appointed Dec. 29, 1913, and its report was dated Jan. 7, 1914. (Some statements from this report were presented and some points in the Chicago sewage-disposal situation were discussed in an editorial note printed on p. 421 of our issue of Feb. 19, 1914.)

The crux of the whole problem, Mr. Pearse says in effect, is the volume of Lake Michigan water which is to be available for dilution. The Federal permit for 4167 cu.ft. per sec., Mr. Pearse states, was to govern the velocity through a small portion of the Chicago River in its relation to shipping and does not involve the total amount of diversion, since "water can be pumped in otherwise, through 39th St. and the South Fork." Since this volume limit in the interest of navigation was fixed $11,000,000 have been spent "in improving the Chicago River and reducing velocities," and preparations for further improvements are being made. The Sanitary District "has never recognized the right of the United States government to fix the total diversion from Lake Michigan." For several years, the District has actually been drawing more than 4127 cu.ft. per sec. of water from lake, and at "times up to 10,000 cu.ft. per sec., and this it has never denied. Moreover, it has been well known from the start that the legislative act creating the District requires a certain volume of diluting water and that the drainage works built or being built under that act and the supplementary legislation are designed for a diversion of 14,000 cu.ft. per sec. Notwithstanding all this:

The United States Government at present is seeking to enjoin the district from using more than 4127 cu.ft. per sec. as a total diversion from the lake. If this injunction is enforced, it will impress upon the community the immediate expenditure of over $100,000,000 to merely duplicate works now in service without [increasing?] their efficiency in protecting the water-supply of the city, and including cost of operation the damage to the taxpayers will exceed $200,000,000.

This immense outlay, Mr. Pearse asserts, "would benefit only a few, namely, the ore shippers through the St. Clair River." Greater fluctuation in lake levels than those caused by water diversion to the Canal, he asserts, are "caused by variations in the rainfall and by winds, and even by the acts of the government engineers themselves, in dredging channels between the lakes."

Answering assertions in the Alvord report to the effect that an increase in typhoid fever in Chicago indicated the contamination of the water-supply by sewage, Mr. Pearse states that the rise in typhoid in Chicago in 1913 was slight and that even with a rise there were but 246 deaths, or less than 10 per 100,000. Moreover, analyses show that hygienically the water-supply of Chicago was better in 1913 than in 1912.

As to the need of engaging outside engineers to study the questions at issue, Mr. Pearse states that within the past two years the District has had the benefit of the advice of the following eminent members of the profession: Geo. W. Fuller, Allen Hazen, F. P. Stearns, Rudolph Hering, Gardner S. Williams and John R. Freeman.

Mr. Pearse states that "the weight of opinion of these gentlemen is wholly to the fact [effect?] that at present, Chicago has a remarkably good water-supply, and that this condition is due entirely to the diversion of the sewage."

Toward the end of his report, Mr. Pearse suggests that the citizens of the Sanitary District arouse themselves and awaken their representatives in Congress to induce that body to authorize a diversion of 14,000 cu.ft. per sec.

After calling attention to the successful effort of San Francisco to get Congressional authority for its proposed Hetch Hetchy water-supply, Mr. Pearse states that Chicago's need of Lake Michigan water for health and cleanliness seems more important than the navigation interests.

Municipal Electric-Supply Stations in the United States show substantial gains for the decade 1902-1912, according to preliminary figures just issued by the U. S. Bureau of the Census. The data are given in the accompany table. The bureau reports that as a rule no cash income was derived by municipal stations for street lighting, etc., and in order that the income might approximate the total sale of current by such stations it was indicated as estimated for service of similar character by commercial companies in near-by localities.

	1912	Per cent. of increase: 1902-1912
Number of stations	1,562	91.7
Income	$23,218,989	233.4
Electric service (light, heat, and power, including fire service)	22,663,708	231.5
All other sources	555,281	333.0
Total expenses, including salaries and wages	16,917,165	222.5
Total number of persons employed	7,940	132.4
Total horsepower	559,328	249.5
Steam and gas engines (including turbines):		
Number	2,307	114.0
Horsepower	429,067	190.0
Water wheels:		
Number	269	328.0
Horsepower	130,261	1,061.2
Kilowatt capacity of dynamos	368,677	225.2
Output of stations, kilowatt hours	537,526,730	174.4
Estimated number of lamps wired for service:		
Arc	91,851	80.8
All other	7,057,849	347.4
Stationary motors served:		
Number	21,895	1,016.0
Horsepower capacity	164,291	4,842.6

Annual Convention of the American Railway Engineering Association

The 15th annual meeting was held at the Congress Hotel, Chicago, Mar. 17 to 19, with a registered attendance of nearly 500. There were six business sessions, and the only entertainment was the annual dinner. The principal speakers at the dinner were Hon. Charles A. Prouty, Director of the Division of Valuation, Interstate Commerce Commission; Hon. Charles Marcil, formerly speaker of the House of Commons, of the Canadian Parliament; and Mr. Schoonmaker, President of the Pittsburgh & Lake Erie R.R. Mar. 20 was nominally a convention day, being set aside for attendance at the large and varied exhibit of railway materials and appliances at the Coliseum. Each of the 21 committees had a report, dealing with from one to seven or eight subjects, but the reports were less voluminous than in some previous years. A weak point in the meeting was the character of the discussions, which did not rise to the opportunities. Except for a few subjects the remarks were somewhat inconsequential, and there was comparatively little of the constructive criticism and the brisk interchange of experience and opinion, which the occasion demanded.

The meeting opened with the address of the President, Edwin F. Wendt (Engineering Board, Interstate Commerce Commission) which reviewed a number of matters relative to railway engineering in general and the work of the Association in particular; special attention was given to the present problems of electrification and valuation. He announced also that a joint committee of the American Engineering Association and the American Society of Civil Engineers has been appointed to conduct a series of tests to determine stresses in track, and that the U. S. Steel Corporation has offered $10,000 toward the expenses of these tests.

The report of the Secretary, E. H. Fritch, showed a membership of 1147 (1100 in the United States and Canada), and the following financial condition: balance at end of 1912, $10,745; receipts for 1913, $25,879; expenditures, $22,347; balance at end of 1913, $14,277. The same showing was made in the report of the Treasurer, Geo. H. Bremner. The officers for 1914 are as follows: President, W. B. Storey, Vice-President, Atchison, Topeka & Santa Fé Ry. System, Chicago; Vice-Presidents, Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines (Northwest System), and A. S. Baldwin, Chief Engineer, Illinois Central R.R.; Treasurer, Geo. H. Bremner, Assistant District Engineer, Interstate Commerce Commission; Secretary, E. H. Fritch, 900 So. Michigan Ave., Chicago.

We give below a brief review of the reports and discussions, and abstracts of some of the reports will be given separately.

Roadway and Track

Roadway—The committee presented particulars of model tests as to unit pressures on roadbed, and also observations as to the wave movement of the roadbed under trains. While the loading of roadbed has been compared to that of foundations, the former has conditions of exposure and alternating stresses which do not obtain in foundations. The committee also presented some discussion on tunnel construction and ventilation.

The discussion showed a great diversity of opinion as to the value of tests on the bearing power of [illegible] roadway. The committee outlined some rather high-flown advantages, but Prof. Turneaure (Univ. of Wis.) was doubtful as to the design of apparatus capable of measuring the stresses, while Mr. Sullivan (Chicago & Pac. Ry.) thought the results would be useless. For instance, in the same soil the conditions will be very different with the soil wet and dry. As a more promising line of investigation he suggested the lateral pressures of engines and cars on curves. He has made numerous tests of this kind, with rather unexpected results, and in some cases freight cars and Pullman cars were found to exert greater lateral pressure than the locomotives. Other members thought the load tests on roadway would give some useful result, especially in indicating the economic value of a more liberal use of ballast.

Ballast—The committee submitted the ballast cross-sections of a number of railways, and recommended trials of its proposed section with 24 in. of ballast under the tie. This section includes a top course of broken stone and a bottom course of finer material, such as gravel. It gives a much greater depth and quantity of ballast than is now used by any railway, and in general, American railways have too little ballast. Naturally, there were opposing opinions as to the proposed section, some members approving it as in line with progress, while others considered it excessive in quantity and cost. No action was taken, as the influence of depth of ballast will be one of the subjects involved in the investigation of stresses in track, to be made by a special committee. The report included some information as to cleaning stone ballast, and gave an appendix describing such work with screens on the Baltimore & Ohio R.R., as described in Engineering News, Sept. 4, 1913.

Ties—On the subject of the economy in labor and material effected by the use of treated ties, the committee reported numerous points in favor of such ties. From returns covering 230,000 miles of railway, the results are summarized as follows: life and cost of ties; treated, 13.85 years, $1.03; untreated, 7.78 years, 76c. The average cost of removing an old tie and putting in a new one is 23c.; and there is the undetermined (but considerable) cost due to disturbance of ballast and track surface. The committee included in its report the article on "An Economic Comparison of Railway Ties of Different Materials," by Neil W. Campbell, in Engineering News, Sept. 22, 1910.

In regard to tie-plates, the general opinion favors ribs not over $\frac{3}{16}$ in. deep, rather than deep ribs or claws, but flat-bottom plates are not satisfactory (as they become loose and wear the tie) unless used with screw spikes. Tests of spikes indicate advantages for sharp diamond or pyramidal points and blunt or truncated diamond points as compared with the ordinary chisel point, both as to the holding power and the effect on the wood. The holding power of screw spikes is more than 50% higher than that of common spikes; as the weight of the former is 50% greater, the advantage for equal weight of metal is 25%. In its annual review of experiments with metal and concrete ties, the committee mentioned the action of one inventor in trying to persuade Congress to order the Interstate Commerce Commission to investigate and test his tie. A resolution to this effect was introduced in the House, and referred to a committee.

The discussion related mainly to the question of spikes. Mr. Trimble (Pennsylvania Lines) has found that screw spikes will work loose, but Mr. Downs (Illinois Central R.R.) explained that other roads have had the same experience in experimental work, this being due to improper driving of the spikes. Mr. Ray (D., L. & W. R.R.) stated that in tracks with heavy traffic and fast trains the screw spikes do not work loose and they have greater lateral resistance than the common spikes. They must be screwed home once or twice, however, after being placed, in order to take up the initial compression of the tie. Mr. Storey (A., T. & S. F. Ry.) has also found this necessary; he considers that common spikes will hold better vertically and laterally if driven in bored holes, owing to the decreased amount of injury to the wood. He has not found that tie-plates with cross-ribs seriously injure the tie.

Rails—The question of the design of rails heavier than 100 lb. per yd. is under consideration, and the committee considers it inadvisable for railways to purchase rails lighter than 80 lb. for renewals on main track. Rail failures are still being studied, and it is noted that failures in the base have been few in rails of comparatively thick base, like the A. R. A. (B) type. For rail-joints, a uniform bolt-hole spacing of 5½ in. is recommended for four-bolt and six-bolt joint, with bars 24 in. and 32 in. long, respectively. An appendix by M. H. Wickhost discussed the influence of aluminum on bessemer ingots and rails. This alloy gives ingots of more uniform composition (with larger pipes but denser steel), while the rails have greater strength and toughness.

Mr. Trimble (Pennsylvania Lines) stated that there is a tendency to develop new sections by individual roads, a practice which is to be deprecated, as (if continued) it will result in a return to the very lack of uniformity which led originally to the work of the American Society of Civil Engineers. Inquiry shows that many roads are quite satisfied with the present Am. Soc. C. E. sections, after long experience with them. As to rail failures, Mr. Courtenay (L. & N. R.R.) referred to the frequency of transverse fissures as the cause, a development which is being investigated by the committee. Mr. Lindsay stated that on the New York Central R.R. the great majority of failures in 100-lb. rails occur on passenger tracks, which he took as an indication that speed was an important factor in the cause of rail breakages.

Track—A systematic investigation of the economics of track labor is being made by a subcommittee which has laid out a program covering a term of years. The equation of track values is being studied in order to arrive at proper units of cost, a basis for apportioning appropriations, and a measure of efficiency of the track foremen and laborers. Another subcommittee has prepared typical plans for crossovers, and a third presented a study of speeds of trains on curves and turnouts.

An appendix discussed the plan of extending the duties of section foremen to include simple work handled by men of the bridge and building, water service, telegraph and signal departments. The trials so far have not given very satisfactory results, but the committee considers that the plan offers possibilities for economy in maintenance and a possibility of attracting a higher class of men by the higher salary paid for the enlarged duties. This report was somewhat more favorable than that of the Committee on Signals and Interlocking, on the same subject, which is noted below.

The discussion related to the question of economy and efficiency in track labor. Incidentally it was shown that the fact of the railway fiscal year ending June 30 has considerable influence upon the distribution of maintenance expenses. Mr. Wendt (Interstate Commerce Commission) said he had been unable to find the reason for adopting this date instead of Dec. 31, and it was suggested that the Association might take steps to have the latter and more logical date adopted.

Signs, Fences and Crossings—The committee recommended that further consideration of the improvement of fence wire should be postponed for a few years, or until the few roads trying to effect some progress have concluded their investigations. Designs were submitted for crossing signs and trespass signs, with a review of the laws of various states in regard to crossing signs and trespassing on railways. The crossing sign (of the familiar X-type) was criticized and desire was expressed for a more conspicuous design, but eventually both signs were adopted as recommended practice.

Yards, Signals, Electrification

Yards and Terminals—The report dealt mainly with two subjects: 1, the mechanical handling of freight, and 2, the design and operation of hump yards. The first portion (supplementing former reports) described a variety of appliances used for a variety of purposes at freight houses and industrial plants, and also for handling mail, baggage and express matter. The second portion described the new freight yard of the Canadian Pacific Ry., at Winnipeg, and gave the various replies to a series of inquiries in regard to hump or gravity switching yards.

In the brief discussion, E. H. Lee (Chicago & Western Indiana R.R.) emphasized the position stated in the report as to the difficulties of applying mechanical apparatus at freight houses, and other speakers referred to certain difficulties in the design of gravity yards. Both Mr. Stuart (B. & O. R.R.) and Mr. Downs (Ill. Central R. R.) referred to the importance of proper operation as well as proper construction of yards, in order to raise the efficiency of freight service, and Mr. Stuart suggested that the committee should turn its attention to this phase of the yard problem.

Signals and Interlocking—The committee reported adversely upon the proposition to combine signal maintenance with track maintenance work. The former needs men of special training, and a foreman not having such training could not judge of the efficiency of their work. It would also be uneconomical to attempt to select and train men to be competent to supervise a combined maintenance force. At interlocking plants, the local section foreman might be instructed as to minor mechanical adjustments, but that may involve loss of time. There might be some combining of duties between the forces of the signal department and those of the bridge and building, water service, telegraph, telephone, electrical and mechanical departments.

The committee also submitted the results of some tests as to the conductivity of creosote and creosoted ties in relation to track circuits; also the effect of ballast and bonding conditions.

Water Service—The principal part of this report was an outline of recent developments in water-softening on

railways, particularly as to the relation of the water problem to railway operation. An appendix described tests of the corrosion of ingot iron, tank steel and copper-bearing steel in different soils and in a water found to be highly corrosive on steel plates. The corrosion in all the samples was much the same (except that the ingot-iron showed the least effect in the water); in all cases it was greater in clean sand than in clay and alkali soils, due partially to the fact that the sand allows a circulation of air while the other soils practically exclude the air.

ELECTRICITY—The committee has for some time been working on the subject of clearance limits on electrically operated railways. It presented diagrams for overhead clearance and recommended further study of third-rail clearance limits. A joint committee of this association, the American Railway Association and the American Electric Railway Association, has discussed the question of clearance for automatic stops. It recommends that no further consideration should be given to the matter at present, as these devices are in the experimental stage and no such device has been generally adopted by steam railways.

ECONOMICS OF RAILWAY LOCATION—The majority report suggested that the work of the committee should be performed by men who can give their full time to the investigation planned, and advised an appropriation for such expense for six months. Two members, in a minority report, thought it inadvisable to undertake the expense or work at this time, but that the committee should continue its investigations, especially as to the relative expense of maintenance due to passenger, freight and engine tonnage. The report was accepted as one of progress, without discussion.

BRIDGES AND STRUCTURES

IRON AND STEEL STRUCTURES—One subject reported on was protection against corrosion; this included protection by paint and by concrete, and also the use of blast boards of asbestos and cast iron to protect concrete exposed directly to the blast from locomotive stacks. Another lengthy report was on secondary stresses in trusses, and there were two brief reports on bridge-clearance diagrams and requirements for the protection of traffic at movable bridges.

The discussion related almost entirely to the committee's recommendation for square-cut rail ends at drawbridges. Most of the members favored miter-cut rails as being fully as efficient and giving a better riding track, and this applied to roads operating heavy service and high-speed trains. In fact, Mr. Stein stated that the Newark Bay bridge, of the Central R.R. of New Jersey, carries nearly 300 trains daily on each track, with speeds of 40 m.p.h. and over, and finds the miter-cut rails quite satisfactory. One objection made is that movable rails are necessary and may be an element of danger, but the rails are so connected that the bridge cannot be locked unless they are within ¼ in. or ⅛ in. of their exact position. Mr. Rudd (Pennsylvania R.R.) said that the miter-cut joint is used on all double-track and four-track swing bridges, as being better and safer than the other. By vote of the meeting, the specific recommendation for the square-cut rail was struck out.

WOODEN BRIDGES AND TRESTLES—The principal feature of this report related to the use of guard rails. It recommended metal inner guard rails on all tr[illegible] of open-floor bridges and on the outside tracks o[illegible]id-floor bridges (both deck and through structures) [illegible] 20 ft. long, the guards to extend not less than 50 ft. [illegible]ond the bridge. The subcommittee on formulas for [illegible] piling reported progress, but suggested that the su[illegible] should be combined with the report on retaining-w[illegible] design, now being prepared by the committee on ma[illegible]s. The recommendation for the general use of guar[illegible]ails was attacked by some members, but when put to [illegible] vote it was carried by a vote of 115 to 75.

BUILDINGS—This committee presented some information as to roofing, and as to shop floors (wood, concrete, asphalt and brick). It gave also a review of principles governing the design and equipment of freight houses.

MASONRY—The principal part of this report related to the waterproofing of masonry. It stated that water-tight concrete can be made by proper proportioning and mixing, membrane waterproofing was approved, while caution was advised in the use of compounds integral with the concrete. In regard to corrosion of reinforcing metal in concrete, it was stated that this would not occur in dense concrete, with metal either above or below the water level in fresh or salt water. As to disintegration of concrete, all concrete to be exposed to sea water, alkali waters or gases containing sulphur, and concrete containing reinforcing steel, should be dense, rich in portland cement, and allowed to harden under favorable conditions before exposure.

MISCELLANEOUS

WOOD PRESERVATION—The committee has studied the question of using water-gas oil, but does not recommend this material in view of its uncertain preservative value and its rising price. Nor does it approve of the addition of coal tar to high-grade creosote oil; if the tar is added to lower-grade creosote for commercial reasons (as is now being done extensively), the mixing should be done only at the plant and under the direct supervision of the railway. A discussion on the present practice in determining the absorption of creosote oil in timber treatment was submitted by the committee as a basis for the consideration of new and improved methods. The committee's report stated that the addition of coal-tar to creosote could not be regarded as an adulterant because creosote is made from the tar. This somewhat illogical reasoning was disputed, since it is creosote and not tar that is wanted as a preservative.

The Committee on Rules and Organization presented general rules for employees in the construction department. It has been working also on rules for the guidance of field parties making preliminary and location surveys. The Committee on Records and Accounts resubmitted earlier conclusions (which had not been adopted) on the management of store supplies, and a revision of the conventional signs for use on maps and plans. It gave a list of laws as to reports required from railway companies, and submitted a proposed subdivision of the "roadway and track" item in the maintenance-of-way accounts of the Interstate Commerce Commission. This was referred to the committee for further consideration.

The special committee on Uniform General Contract Forms submitted a blank form for proposals. The special committee on Grading of Lumber reported progress in formulating grading rules for classes of lumber that have

not been standardized, but the work has been retarded by the fact that many of the rules for such timbers (particularly hemlock and western timbers) are still in a process of development. The report of the Committee on Conservation of Natural Resources reviewed briefly the work of the National Conservation Congress, in this country, and the Conservation Commission of Canada. The Canadian Pacific Ry. has created a Department of Natural Resources, which controls the company's lands, mines, and industrial and forestry branches. It is under the direction of an engineer, and its work is to see that the lands produce what the soil is specially adapted for and furnish a full crop of such products, whether agricultural or forest.

Influence of Aluminum upon Steel in Ingots and Rails*

By M. H. Wickhorst†

An investigation was made concerning the influence of aluminum on bessemer ingots and rails, when added to the molds while pouring the steel; and at the same time some tests were made on the influence of silicon on bessemer rails, when added as ferro-silicon to the molds. Four ingots were split open and a chemical survey was made of these; 11 were rolled into 85- or 90-lb. rails and used for drop tests and transverse tests of the base. This work was done at the South Chicago works of the Illinois Steel Co., which furnished all the material.

Five ingots were of untreated bessemer steel, eight were treated with aluminum varying from 1 to 10 oz. per ton of steel, and two ingots were treated with additions of ferro-silicon equivalent to 0.1 and 0.2% of silicon respectively. These latter were rolled into rails.

The ingots used for splitting and chemical survey had about 0.44% carbon. The plain ingot had a large central cavity or pipe in the upper part and a large number of small elongated holes along the sides in the upper part. This ingot also had a raised top. The other three ingots treated respectively with 1 oz., 2 oz. and 5 oz. of aluminum per ton of steel, had somewhat larger pipes, but were free from the small elongated holes along the sides. They had flat or sunken tops. Expressed differently, the aluminum-treated ingots had larger pipes, but contained denser steel around the pipes. One ounce of aluminum per ton had considerable influence in this direction and the effect increased a little with increase of aluminum.

The chemical surveys showed a more even distribution of the material in the aluminum-treated ingots, with less segregation or concentration of carbon, phosphorus and sulphur in the interior and upper part. Both plain and treated ingots showed "soft centers" in the lower part of the ingot, that is, there was negative segregation of carbon, phosphorus and sulphur in the interior and lower part of the ingot. The walls of the treated ingots showed a fairly uniform composition throughout their heights. The plain ingot showed a considerable softening or negative segregation in the upper corners. The carbon, phosphorus and sulphur increased in the wall downward until the average composition of the steel was reached at about one-third of the height from the top, after which the wall remained of about uniform composition.

Rails were made of steel of two grades of hardness, one of about 0.45% carbon rolled into 85-lb. rails and the other of about .061% carbon rolled into 90-lb. rails. Some were of plain steel, some treated with aluminum varying from 2 oz. to 10 oz. per ton and two were treated with 0.1 and 0.2% of silicon added as ferro-silicon.

In the drop tests, the use of aluminum was in general attended with a considerable increase in ductility in the upper part of the bar, where the ductility was low in the plain steel, especially with the higher carbon. The addition of silicon had a similar effect, especially with the 0.2% addition. With the 0.45% carbon steel, the average ductility of the whole bar was about the same in the aluminum treated as in the plain steel, but with the 0.61% carbon steel, it was considerably greater in the aluminum-treated bars.

The aluminum additions and the larger addition of silicon were attended with interior flaws extending downward a considerable distance (30 to 45% of the weight of the ingot) from the top, while with plain steel interior laminations as seen in the fractures of the drop-test pieces were absent or close to the top end. The aluminum and silicon additions were made to the molds while pouring the steel, and whether the interior laminations in the rails would occur in the same way if the additions were made to the ladle before pouring the steel into the molds, this investigation does not show.

Incidental to this work, some results were obtained concerning the influence of carbon on ductility as measured in the drop test. The elongation for 0.45% carbon averaged about 27% and for 0.61% carbon about 17%. Roughly, the elongation decreased 0.6% for each 0.01% increase in carbon, between the above carbon limits.

Transverse tests of the base were made by supporting pieces of rail 2 ft. long, on two supports placed opposite each other near the edges of the flanges under the middle of the length of the piece tested. The supports were 6 in. long and were placed ½ in. in from the sides of the flanges. The load was applied in the test machine to the head of the rail at the middle. With the 0.61% carbon steel, treatment with 2 oz. of aluminum was attended with considerable increase in transverse strength and sag of flange before breaking. With treatments with 5 oz. and 10 oz. of aluminum per ton of steel, there were some further increases. With the 0.45% carbon steel, there were small increases in transverse strength and sag of flange with the aluminum treatments as against plain steel.

To sum up, ingots treated with aluminum added to the mold were of more even composition throughout than plain bessemer steel. There was less positive segregation in the interior and upper part of the ingot, but the negative segregation or soft center in the interior and lower parts of the ingot was about the same. There was a softening or negative segregation in the upper part of the wall of the plain ingot, while in the aluminum treated ingots the walls were of fairly even composition throughout the height of the ingot. Aluminum-treated ingots had larger and deeper pipes than plain steel, but had denser steel around the pipes.

Rails of plain steel had a brittle zone in the upper part of the bar as disclosed by the drop test. In the rails of aluminum-treated steel this zone was largely eliminated. Rails of plain steel contained their laminations close to the top end of the bar, while in aluminum-treated rails, the interior laminations were found a considerable distance from the top end, varying from about 30 to 45% of the weight of the ingot. In the transverse test of the base, rails of aluminum-treated steel showed considerably greater transverse strength of the base and sag of the flange before breaking, than the rails of plain steel, with 0.61% carbon and a little greater strength and sag of flange with 0.45% carbon.

*Summary of a report forming an appendix to the report of the Committee on Rails, presented at the annual meeting of the American Railway Engineering Association, held at Chicago, Mar. 17, 20.

†Engineer of Tests, Rail Committee, American Railway Engineering Association, 900 S. Michigan Ave., Chicago.

Guard Rails on Railway Bridges*

A large majority of the replies to a circular of inquiry recommended the use of guard rails on through bridges. The protection of trains and the lives of their passengers and crews is more important than the protection of structures. If guard rails are a protection to through bridges, which means that they assist in guiding a derailed train, they will equally be a protection to trains which may be derailed on deck structures, and are, therefore, desirable.

As to the danger of brake-rigging catching in the ends of guard rails, this objection can be met by beveling or bending down the ends of guard rails or frog points to the level of the deck.

CONCLUSIONS—1. It is recommended as good practice, in the installation of guard rails, to extend them beyond the ends of the bridges for such distance as is required by local conditions, but that this distance, in any case, be not less than 50 ft. The guard rails should be fully spiked to every tie, and spliced at every joint. These guard rails should be some form of metal section; and the ends should be beveled, bent down, or otherwise protected against direct impact with moving parts of equipment.

2. It is recommended as good practice to use inner guard rails on all open-floor bridges and on the outside tracks of all solid-floor bridges and similar structures longer than 20 ft. in main-line tracks, and on similar bridges and structures in branch-line tracks on which the speed of trains is 20 m.p.h. or more.

*From the report of the Committee on Wooden Bridges and Trestles, presented at the annual meeting of the American Railway Engineering Association.

Tie Plates and Track Spikes

The report presented by the Committee on Ties at the annual meeting of the American Railway Engineering Association, at Chicago (Mar. 17-20) presented some general conclusions regarding tie-plate and track spikes, which conclusions had been submitted to and approved by the engineers of a number of leading railways. These conclusions were as follows:

1. Tie-plates with deep ribs or claws cut the tie so as to admit moisture and decay. The deep ribs or claws are not necessary to hold the plate in position and are undesirable.

2. Flat-bottom plates used with cut spikes become loose and the looseness results in mechanical wear of the tie. They are satisfactory when used with screw spikes.

3. Plates with cross-ribs not over $\frac{1}{8}$ in. deep, or other independent fastenings that will hold them to the tie, do not seriously damage the tie and at the same time do not become loose and cause mechanical wear when used with ordinary cut spikes.

4. The width of the tie-plate is an element to determine the mechanical wear of the tie; plates less than 7 in. wide, for use with softwood ties, cut into the tie sufficiently in some cases to limit the life of the tie.

5. The plates should be of sufficient thickness to avoid cupping on either side of rail. This thickness depends on the projection beyond the rail, the amount of traffic, the kind of tie and the rate of deterioration from rust, etc.

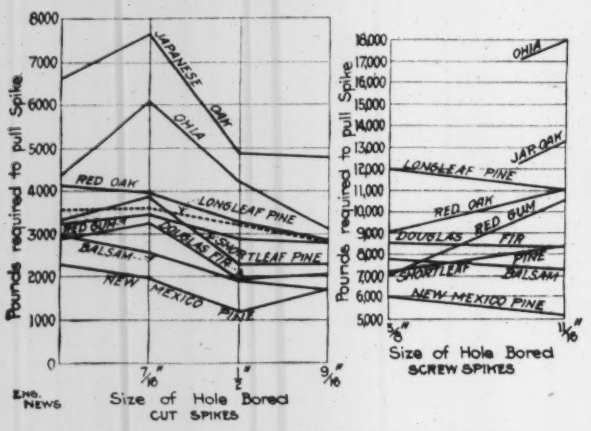


FIG. 1. DIAGRAM OF HOLDING POWER OF ORDINARY SPIKES AND SCREW SPIKES IN DIFFERENT WOODS

6. Screw spikes prolong the life of ties over that obtained with cut spikes.

7. Where treated ties are used, all boring should preferably be done previous to treatment.

8. Ordinary driven cut spikes, by breaking down the structure of the wood for an inch, or so around the spike, facilitate decay at that point where greatest strength of the tie is required. In the case of treated ties, this introduction of decay below the treatment may defeat the purpose of treatment.

9. The breaking down of the structure of the wood, with the use of cut spikes, is, to a considerable extent, avoided where the spike is driven in a bored hole. Spikes so driven have at least the same holding power as spikes driven without boring. Where spike holes are to be bored and cut spikes used, the diamond-pointed cut spike is preferable, because of the greater ease with which it follows the hole.

TESTS OF THE HOLDING POWER OF TRACK SPIKES

The committee's report was supplemented by two reports on tests of spikes, prepared by H. B. MacFarland, Engineer of Tests of the Atchison, Topeka & Santa Fé Ry.

FORM OF SPIKE POINTS—The first of these reports dealt with spikes having three forms of points: 1, chisel; 2, sharp point (pyramidal); 3, blunt or truncated pyramid. In the third set, the points were of four different lengths. The spikes were about $\frac{1}{2}$ to $\frac{5}{8}$ in. square and 5.3 to 5.8 in. long, but all were driven the same depth, $4\frac{1}{8}$ in., and pulled in a testing machine. The particulars of the spikes and their resistance are given in Table I, which shows the average values for all pulls in fir, red oak and white oak ties having bored holes $\frac{3}{8}$x4 in. It will be seen that the ordinary chisel-pointed spike makes the poorest and the sharp-pointed spike makes the best showing. The columns headed "start" show the initial force to overcome all resistance and start the spike; those headed "pull" show the average resistance after the spike has been started and is being drawn.

TABLE I. TESTS OF HOLDING POWER OF SPIKES HAVING DIFFERENT FORMS OF POINTS

Type	Point Length, in.	Point End, in.	Resistance, lb. Start	Resistance, lb. Pull	Tons holding power per ton of metal Start	Tons holding power per ton of metal Pull
Chisel	1.10	0.05x0.055	4590	2920	8020	5110
Sharp	1.10	0.06	5300	3590	9510	6440
Blunt	0.50	0.25 sq.	5020	3615	8450	6060
Blunt	0.80	0.25 sq.	5160	3700	8700	6310
Blunt	1.25	0.25 sq.	5010	3040	8870	5370
Blunt	1.70	0.25 sq.	5110	3080	9400	5670

TABLE II TESTS OF HOLDING POWER OF CUT SPIKES AND SCREW SPIKES, AND COMPRESSION OF WOOD

	Cut spikes Hole, in.	Cut spikes Resist. lb.	Screw spikes Hole, in.	Screw spikes Resist. lb.	Pressure to indent lb. per sq.in. ¾-in	Pressure to indent lb. per sq.in. 1-in
Long-leaf pine	None	3583			860	1082
Long-leaf pine	$\frac{7}{8}$	3598	$\frac{1}{2}$	11,970		
Long-leaf pine	$\frac{9}{8}$	3215	$\frac{11}{16}$	10,990		
Short-leaf-pine	None	3323			1225	1480
Short-leaf pine	$\frac{7}{8}$	3870	$\frac{1}{2}$	7,215		
Short-leaf pine	$\frac{9}{8}$	2275	$\frac{11}{16}$	8,355		
New Mex. pine	None	2285			816	977
New Mex. pine	$\frac{7}{8}$	1970	$\frac{1}{2}$	6,025		
New Mex. pine	$\frac{9}{8}$	1190	$\frac{11}{16}$	5,195		
Red oak	None	4120			1306	1670
Red oak	$\frac{7}{8}$	3950	$\frac{1}{2}$	9,055		
Red oak	$\frac{9}{8}$	3265	$\frac{11}{16}$	11,090		
Red gum	None	3265			1088	1320
Red gum	$\frac{7}{8}$	3478	$\frac{1}{2}$	7,000		
Red gum	$\frac{9}{8}$	2872	$\frac{11}{16}$	10,310		
Douglas fir	None	2883			968	1080
Douglas fir	$\frac{7}{8}$	3268	$\frac{1}{2}$	8,555		
Douglas fir	$\frac{9}{8}$	1928	$\frac{11}{16}$	8,333		
Balsam	None	2968			739	863
Balsam	$\frac{7}{8}$	2540	$\frac{1}{2}$	7,780		
Balsam	$\frac{9}{8}$	1913	$\frac{11}{16}$	7,295		
Ohia	None	4315			2400	2780
Ohia	$\frac{7}{8}$	6073	$\frac{1}{2}$	*		
Ohia	$\frac{9}{8}$	4207	$\frac{11}{16}$	18,010		
Jap. oak	None	6595			2,000	2530
Jap. oak	$\frac{7}{8}$	7650	$\frac{1}{2}$	*		
Jap. oak	$\frac{9}{8}$	4853	$\frac{11}{16}$	13,253		

* Spike could not be screwed in.

DRIVE AND SCREW SPIKES—These tests of holding power were made with $\frac{5}{8}$-in. cut spikes weighing $9\frac{1}{2}$ oz. (169 spikes per 100 lb.) and $\frac{5}{8}$-in. screw spikes weighing 19 oz. each (84 per 100 lb.). The latter were $\frac{7}{8}$-in. diameter over the rolled V-thread of $\frac{1}{2}$-in. pitch. The tests were made in various woods, including Japanese oak and ohia, which are very hard, and the screws could not be forced into the $\frac{1}{2}$-in. holes in these woods. For the cut spikes, holes $\frac{7}{8}$ in., $\frac{1}{2}$ in. and $\frac{9}{8}$ in. were used, but in most cases the resistance was least in the largest holes. The results are summarized in Table II. A compression test was made also to determine the pressure required to sink a rail into the wood, with results as in Table II.

CONCLUSIONS—The relative weight of the cut spikes as compared with the screw spikes is 1 to 2, and their relative maximum holding power averages 1 to $2\frac{1}{2}$, respectively, thus indicating an advantage of 25% for the screw spike over that of the cut spike, equal weights of metal being considered. It will be noted from the accompanying cut that in the majority of cases the cut spikes driven in the $\frac{7}{8}$-in. holes require the greatest force to remove them. The long-leaf pine exhibits about the same holding power with no hole and with $\frac{7}{8}$-in. hole, while the red oak, balsam and New Mexico pine display a somewhat higher power with no hole bored for the spike.

FIG. 2. COMPARATIVE EFFECTS OF DIFFERENT FORMS OF SPIKES DRIVEN INTO WOOD WITH AND WITHOUT BORED HOLES

(The six upper sections show the effects with spikes driven in ¾ in. bored holes. The six lower sections show the effects with spikes driven without bored holes.)

With the screw spikes there are but seven comparisons to make, since it was impossible to screw the spikes in ⅝-in. holes in the ohia and Japanese oak. In these seven cases, however, the red oak and the red gum, which are the hardwoods, reveal a much greater holding power with the spikes screwed into the larger hole; while in the long-leaf pine, Douglas fir, balsam and New Mexico pine, which are soft woods, the holding power of the spikes is somewhat higher with the smaller hole, although the difference is not so marked as in the case of the hardwoods.

The fibers of the red gum, balsam, long-leaf pine and red oak were not broken at all by the rail in the compression test, which indicates a very elastic fiber in the wood. The Japanese oak and ohia show a very slight breaking of the fiber. Douglas fir, short-leaf pine and New Mexico pine presented very brittle fibers, which were broken considerably by the rail when under compression.

Engineers and Railway Valuation*

BY EDWIN F. WENDT†

On Mar. 1, 1913, Congress passed the Valuation Act, under which the Interstate Commerce Commission is authorized to make a valuation of all common carriers of the United States. The term "common carrier" includes steam railways, electric railways, water lines, express companies, sleeping-car companies, pipe-line companies, telegraph lines, and telephone lines. The problem of valuation is one of gigantic proportions, because it deals with property which is capitalized at about $20,000,000,000.

There is no precedent in any country for this important work, whose purpose is to establish a basis for the regulation of rates. In no other country have valuations ever been made for purposes of regulation. It therefore appears that a new work has been undertaken which will accomplish results of the greatest interest. Valuation is a problem involving law, engineering, accounting, and economics. The corporation is organized under the law, followed by the construction of the property, the accounting for its cost, and finally, the consideration of the results of its operation.

A duty will rest upon engineers in connection with this valuation work, because it is necessary to determine the cost of reproduction, which is distinctively an engineering problem. Congress has ordered, "That the Interstate Commerce Commission shall investigate, ascertain, and report the value of all the property owned or used by every common carrier subject to the provisions of this act. The Commission shall make an inventory which shall list the property of every common carrier in detail, and show the value thereof, and shall classify the physical property, as nearly as practicable, in conformity with the classification of expenditures for road and equipment as prescribed by the Commission."

The Commission is required to ascertain and report in detail as to each piece of property: 1, the original cost to date; 2, the cost of reproduction new; 3, the cost of reproduction less depreciation; and, 4, other values and elements of value.

ORIGINAL COST TO DATE—It is probable that the original cost of many railways cannot be determined, because records have been lost or burned or destroyed. Railways built before the passage of the Hepburn Act, in 1906, kept their accounts in accordance with a multitude of accounting systems, and charges to capital were determined by a variety of principles. Uniformity of method in accounting was unknown, and where additions and betterments were made, the cost was divided between operation and investment according to the economic principle which was adopted by a particular carrier.

Railways constructed since July 1, 1907, have been re-

*Abstract of a portion of the presidential address at the annual meeting of the American Railway Engineering Association, at Chicago, March 17, 1914.

†Member of the Engineering Board of the Division of Valuation, at Chicago, Mar. 17, 1914.

quired by the Interstate Commerce Commission to report their investments in accordance with a uniform system of accounts, by which charges to capital account were determined on the basis of a uniform principle. The original cost of these roads can be determined.

The determination of the "original cost to date" of railways, whether built before or after the passage of the Hepburn law, is largely an accounting problem. However, many difficulties will arise in connection with the preparation of a final inventory, and it is probable that a portion of the responsibility will rest on engineers.

COST OF REPRODUCTION NEW—The Commission is required to determine the cost of the reproduction of railways just as if they were being built anew, and the act specifically requires that a detailed inventory shall be prepared, and that the units of the property shall be classified. In order to accomplish this purpose, it will be necessary to remeasure the units of the railways of the country, which, at the present time, amount to about 250,000 miles of road. The work of estimating is essentially an engineering problem, and will require the best energies of the engineers of this country.

COST OF REPRODUCTION LESS DEPRECIATION—The depreciation problem is complex and has a bearing on the determination of "fair value." Considerable attention has been given to the depreciation problem in connection with waterworks, gas plants, and other municipal utilities. But so far as the steam-railway business is concerned, the principle of depreciation has not been generally recognized heretofore in the keeping of investment accounts.

The Supreme Court has decided that depreciation shall be deducted from the cost of reproduction, but there are various methods for computing the amount, and the problem now is to determine the method which will yield a result which will be just and true and fair. This work will involve an extended study on the part of engineers, economists, attorneys, and accountants.

OTHER VALUES AND ELEMENTS OF VALUE—Congress has recognized the fact that valuation is a complex problem, and has ordered that every feature of the business of common carriers shall be investigated and studied in order that "other values, and elements of value, if any, of the property," shall be reported. This work opens up a large field for valuation experts.

KEEPING VALUATIONS UP TO DATE—It is provided that upon the completion of the valuation the Commission shall keep itself informed of all extensions or improvements or other changes in the condition and value of the property, and shall ascertain this value, and shall (from time to time), revise and correct its valuation. The valuations, both original and corrected, are to be considered as tentative, and to be reported to Congress at the beginning of each regular session. This is a work of great magnitude for construction and maintenance engineers, on whom will rest the responsibility of determining what units of an improvement are to be charged to investment and what units must be charged to operating expenses on account of replacement. Engineering accountants will be required in the offices of original record, and the field of usefulness for the engineer who understands the principles of accounting will be greatly enlarged. Cost accounting is an important branch of railway engineering.

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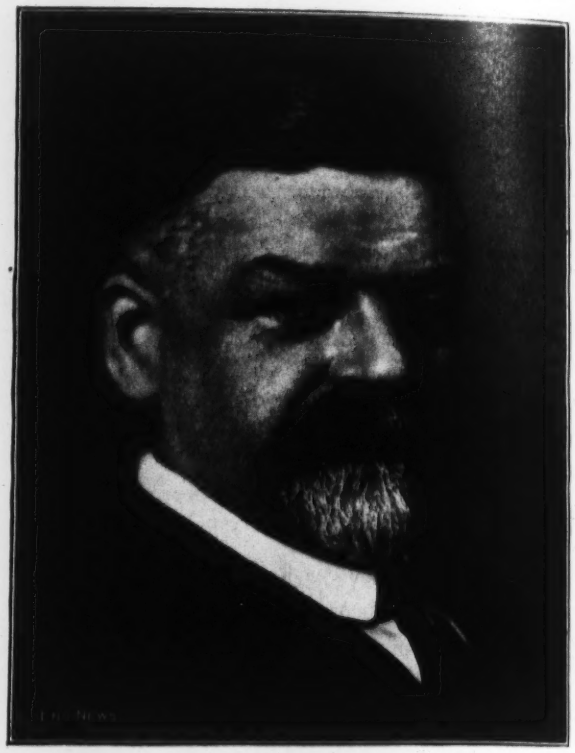
W. B. Storey, President of the American Railway Engineering Association

William Benson Storey, now Vice-President of the Atchison, Topeka & Santa Fé Ry. System, was born at San Francisco, Calif., Nov. 17, 1857, the son of William Bainbridge and Ellen (Dean) Storey. He commenced his railway career as a rodman on railway work during the vacation of 1876, and in 1877-78 he was with engineering parties on the Central Pacific Ry. In 1878, he entered the University of California, graduating in 1881, with the degree of Ph. B., which was the only degree then given in scientific courses by that institution. In June, 1881, he reëntered the service of the Central Pacific Ry., as a rodman, and he continued with this road and its successor, the Southern Pacific Ry., until August, 1893, with the exception of about one year, when he was engaged in private practice in San Francisco.

Beginning as rodman on that system, he [illegible] to the positions of chainman, leveler, transitman [illegible]ation and construction work, assistant engineer [illegible]rge of location, and later in charge of construction [illegible] reconstruction of various lines. Early in his [illegible]e was engaged on the location and construction [illegible]present line through the mountain region in northe[illegible]fornia, on the California-Oregon connection. He [illegible]t pro- tion of what is now known as the Coast [illegible] of the Southern Pacific System, extending from San [illegible]ncisco to Los Angeles (through Santa Barbara), [illegible] also re-



built stretches of line in Arizona and New Mexico, which had to be reconstructed due to extended washouts.

From 1894 to 1895, he was assistant engineer with the United States Débris Commission, which had been appointed to investigate the injury to rivers in California by the hydraulic system of mining or sluicing gold-bearing gravel. He was engaged in inspecting the impounding of tailings from these hydraulic mines, and also in supervising the construction of impounding works.

In 1895, he became Chief Engineer of the San Francisco & San Joaquin Valley Ry., which had been projected by Mr. Spreckels and other local interests for the purposes of getting an independent line into San Francisco, which was then served only by the Southern Pacific Ry. The line extended from Bakersfield to Point Richmond, on San Francisco Bay, and was described in ENGINEERING NEWS, Oct. 29, 1896. Mr. Storey later became Gen-

eral Superintendent as well as Chief Engineer and built the entire line (about 400 miles), having charge of the location, construction and operation. The work included difficult construction across the marshes west from Stockton, and the mountain work across the Coast Range on the approach to San Francisco.

Upon the completion of this road in 1900, it was purchased by the Atchison, Topeka & Santa Fé Ry., which thus gained independent access to San Francisco and in July commenced a through train service between Chicago and San Francisco. In 1900, also, Mr. Storey became Chief Engineer of the larger road, with offices at Topeka, Kan., and during the next six years he had charge of all maintenance and engineering, including much grade improvement and double tracking. In 1906, he was made Chief Engineer of the Atchison, Topeka & Santa Fé Railway System (with offices in Chicago), being in charge of all construction work and acting as consulting engineer on maintenance matters. In 1908, he was made Vice-President of the railway system, in charge of construction, and in 1910, he became Vice-President in charge of operation and construction for the entire Atchison, Topeka & Santa Fé System, which position he now holds. This railway system now comprises some 10,750 miles, and during Mr. Storey's years of service there has been extensive work in the construction of new lines, the revision of old lines, and a general improvement in standards and efficiency.

He is a charter member of the American Railway Engineering Association, has served on several of its committees, and has been successively a Director (1911) Second Vice-President (1912) and First Vice-President (1913). He has been a member of the American Society for Testing Materials, the Technical Society of the Pacific Coast, and the Western Society of Engineers.

Work at the Keokuk Dam across the Mississippi River

Rumors have been in circulation among engineers in various parts of the country that the great Mississippi River dam, at Keokuk, has developed leakage since it was put in service, necessitating extensive repairs.

These rumors have doubtless grown out of the fact that certain work, which is described below, has been done on the dam since it was completed last summer, but there has been no leakage, we are authentically informed, since the dam was put in service and the work which is in progress cannot be properly called repairs. It consists in brief of filling with concrete the cavities eroded in the rock of the river bed below the dam and of inserting anchor rods in the body of the dam.

The dam is founded on a limestone bed, which was excavated in an open coffer-dam to a depth of from 3 to 10 ft. below the natural rock surface. It was understood when the dam was built that the force of the falling water going over the spillway would very likely cause erosion of the stratified limestone rock below the toe of the dam. At some places a concrete apron was made below the toe of the dam when it was built to provide a smooth flow line over the spillway to the natural rock bed; but elsewhere the rough face of the rock excavation was left.

The expected erosion has taken place all along the dam. The water falling over the spillway has ripped out layers of the rock and piled it up in considerable volume downstream. Below buttresses 1 to 15 (numbering from the Illinois side) there is quite a large pile of rock close to the dam at low water, scattered over a distance of 300 ft. Below buttresses 36 to 58 and 68 to 106, there is about 100 ft. of open water and then from 200 to 300 ft. of loose rock piled up. There is practically no rock visible below buttresses 58 to 68 and none in the tail race from buttresses 119 to 121, the latter being at the Illinois end of the dam.

During last July and August considerable work was done in filling with concrete the cavities which had been torn out below the toe of the dam, so as to give a smooth flow line and a solid concrete apron for the water leaving the spillway to flow over. This work is shortly to be resumed to finish concreting the remaining cavities.

Another very interesting piece of work which is being prosecuted at the same time is the placing of diagonal rods extending through the body of the dam and down into its rock foundation.

These rods are 2-in. square twisted bars grouted into 3½-in. holes drilled at an angle of 15° in three lines on the curved downstream face of the dam and spaced about 5 ft. c. to c. along the dam. As a rule, one hole is fairly well up on the slope and two are on the toe of the dam.

We are informed that these diagonal anchor rods were planned for in the original construction of the dam and about a third of them were placed at that time. The necessity of hastening the completion of the work, however, led to the omission of these rods on the later portions of the dam, with the intention of putting in these rods after the dam was finished. This work is now in progress. The dam as designed is perfectly safe as a gravity structure. The rods are being added simply to give an additional margin of safety.

The Economic Design of Standpipes and Conduits for water-supply purposes was presented mathematically by H. E. Babbitt (Instructor in Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.) at the annual convention of the Illinois Water Supply Association, Mar. 9-11, 1914. For standpipes a total of 16 factors were considered, including not only the dimensions of the pipe, the thickness and weight of the steel plates, the foundation, costs of materials, labor, etc., but also the cost of pumping water 1 ft. high, and the capital charges "on the extra initial cost of the pipe to decrease the pumping cost." Assuming that the standpipe is to be used for storage between pumping and that it is to be filled and emptied once each day, "the most inexpensive standpipe which can be constructed, whether of 1000 gal. or 1,000,000 gal. capacity, should have a height of 23 ft., if the cost of pumping is not considered," and 15 ft. if it is considered. Changes in the values of one of the 16 factors may materially change the economic height. Thus, if steel be taken at 2c. per lb. instead of 5c. the height should be 36 ft. instead of 23 ft., if pumping costs are ignored, or 17 ft. instead of 15 ft. if pumping is considered.

The studies for the economic design of conduits were based on the following assumption:

> In the design of a large gravity water conduit of any considerable length, passing through various classes of material, and with a limited total loss of head, it is less expensive to allow a relatively steep grade to the more costly portion and a relatively flat grade to the less costly portions, than if the entire conduit were laid at the same grade with the same sections through all classes of materials. It is thus evident that there is some relation between the grades for each section which will give the minimum cost for the entire conduit.

Examples are worked out for different classes of materials, slopes and diameters. In the discussion reference is made to the proposition of Wiggin advanced in "The Catskill Water Supply of New York, by Lazarus White," as proving graphically that "if a series of parallel tangents be drawn to the cost curves such that the sum of the ordinates of the points of tangency is equal to the total permissible head, the least cost of the entire conduit will be obtained by constructing each section of conduit with the loss of head indicated."

NEWS NOTES

A Traction Engine Went Through a Highway Bridge seven miles north of Shenandoah, Iowa, on Mar. 10, killing the driver.

A Subsidence Damaged Many Buildings on High St., Bradley Heath, a colliery town in England, on Mar. 10 and 11. In some parts of the roadway, the subsidence was as much as 6 feet.

A 16-in. Water Main Burst in the Mt. Hope section of the Bronx, New York City, on Mar. 16. The main ran under the Grand Concourse, at Burnside Ave., where the street cars on the Avenue go under the Concourse.

A Severe Storm in Southern Russia caused much damage in the province of Kuban, on Mar. 14, according to cable dispatches. A dam failed in the town of Temryuk on the Taman Peninsula, with damage to property and much loss of life. Many buildings on the east coast of the Sea of Azof were wrecked by the sea, and 1200 persons are reported drowned.

A Pit Cave-in on the Pawpaw-Magnolia cutoff, under construction for the Baltimore & Ohio R.R., at Pawpaw, W. Va., killed four men employed by the Jas. F. McCabe Construction Co., of Baltimore, Md., on Mar. 16, according to press dispatches. About 25 men were in the pit, 20 ft. below the surface, when the slatey soil, softened by the recent warm weather and said not to have been shored, slid.

A Serious Head Collision in Australia occurred on Mar. 14. A mail train and a freight engine collided at Exeter Station, near Moss Dale, causing the death of 10 passengers and the injury of about 15 others, according to cable dispatches. The mail train was proceeding from Sydney to Melbourne. The accident happened in a dense fog.

A Serious Earthquake in Japan, on Mar. 15, caused considerable property damage and the loss of 83 lives in the prefecture of Akita, on the Island of Hondo. The volcano Asama-Yama, 90 miles northwest of Tokio, was in eruption on the same day. Many houses were destroyed and a number of persons killed. Asama-Yama is the largest active volcano in Japan. Its last serious eruption was in 1783.

Rocking a Vessel is to be tried as a means of breaking its way through ice. The Great Lakes car-ferry steamer "Ashtabula," 4500 tons, it is reported, is to be fitted with a Sperry gyroscopic stabilizer adjusted to make the boat roll instead of to overcome the natural oscillation.

Bridge Damage by the Recent California Floods in Ventura County, just north of Los Angeles, is estimated at about $150,000, according to County Surveyor Everetts, who further states that only two of the county's bridges escaped injury.

Lifting Jacks on Street Cars, for quickly releasing any person caught under a car, will be a feature of the safety policy of the Philadelphia Rapid Transit Co. The emergency release service has been improved. Nine emergency districts, each with at least one emergency station, have been established in the city. The equipment of the service includes seven horse-drawn wagons, two auto wagons, two auto wreck wagons, 13 wreck cars and four tower cars—a total of 28 emergency vehicles.

A Union Station Plan Was Considered At An Engineers' Club Meeting when the Civil Engineers' Club of Sioux City, Iowa, discussed and approved a plan for a union station at Third and Jackson Sts., submitted by a special committee of the Club, at the first annual meeting, on Feb. 21. The advantages to be gained by the plan submitted were stated to be as follows: "(1) Lower cost of operation in freight and passenger service; (2) increased freight-handling facilities; (3) doubling of team-track space near the business center; (4) improved trackage facilities to the warehouses; (5) the realization of the city's dream of a union station with no tracks to cross."

Tests of Sand for Concrete are discussed in Bulletin No. 70 of the Engineering Experiment Station of the University of Illinois, which is entitled, "The Mortar Making Qualities of Illinois Sands," by C. C. Wiley, of the Department of Civil Engineering of the University. The bulletin presents the results of tests on 32 representative Illinois sands and discusses the effect of the characteristics of the sand upon the quality of mortar made from them. Specifications for various classes of sand are proposed.

The U. S. Commission on Industrial Relations [illegible] to begin holding public hearings in Washington on Apr. [illegible] en the subjects of collective bargaining, conciliation and [illegible]itration will be considered. A week later, on Apr. 13, a [illegible]ng will be held at Washington on efficiency systems in [illegible]mploy-ment of labor. At a later date hearings are to [illegible]eld by the commission in New York, Philadelphia, Bo[illegible] Pitts-burgh, Buffalo, Atlanta, Birmingham, Memphis, [illegible]sville, New Orleans, Detroit, Indianapolis, Cleveland, C[illegible]o, Mil-waukee, St. Louis, Kansas City, St. Paul, Denver, [illegible]s, Los Angeles, San Francisco, Seattle, Butte and other [illegible]s.

Proposed Memorial to George Westinghouse—A [illegible]mber of prominent citizens of Pittsburgh, Penn., met on [illegible] 16, and formed the Westinghouse Memorial Association [illegible] is the plan of the Association to erect in Pittsburgh [illegible]emorial, probably a monument, to the late George Westing[illegible]use.

Officers were elected as follows: President, H[illegible] Frout, Vice-President of the Union Switch & Signal Com[illegible] Vice-Presidents, J. R. McGinley, President of the Duff Manufacturing Co., and John F. Miller, Vice-President of the Westinghouse Air Brake Co.; Treasurer, W. D. Uptegraff, one of the executors of the Westinghouse estate; Secretary, H. C. Tener, who was private secretary to Mr. Westinghouse.

The Heavy Snow Storm of Feb. 28 as it affected the Pennsylvania R.R. has been well described in an illustrated bulletin just issued by the Publicity Department of the railroad. (Broad St. Station, Philadelphia.) A map shows the location of the numerous trains which were stalled between New York and Philadelphia. Eighteen passenger trains with 2000 passengers on board were marooned in this section. The work of the operating force in clearing the road and repairing damages is fully described.

The New Jackson St. Bridge over the Chicago River will be a fixed trunnion bascule deck bridge, with double leaf, having a span of 202 ft. 3¼ in. c. to c. of trunnions and giving a clear width of waterway of 168 ft. between the lines of protection piling. It will have a 37-ft. roadway and two 13-ft. sidewalks. The present bridge is of the center-pier swing type, 280 ft. long and 58 ft. wide, with three trusses. The east arm spanned the river channel while the west arm spanned a covered bypass with freight tracks and teamways built over a bypass channel for the river. This bypass has been torn out to make room for the coffer-dam of the west abutment of the bascule bridge. The roadway will be paved with creosoted wood blocks on creosoted planking, and the sidewalks will have untreated pine planks on creosoted stringers.

An Irrigation Conference will be held in Denver, Colo., beginning Thursday, Apr. 9, in response to a call issued by Secretary Lane, of the Federal Interior Department. The governors of the states in irrigated parts of the country will attend and will also be represented by delegates. In addition, it is expected that there will be delegates from various private irrigation plants, financial houses and railroads. The subjects scheduled for discussion are: Coöperation between Nation and State; Carey act projects; Irrigation districts; Administration and operation of the desert-land act; Settlement of irrigated lands; Ways and means of financing future works.

Inadequate Fire Protection of Schools in New York City is charged by C. G. Armstrong, former advisory expert of the school committee of the city's Board of Estimate. He reports a number of features of deficient protection or positive danger in various schools, and states that the older school buildings particularly (but also some of the new ones) expose the occupants to grave danger in case a fire should occur in them. The fire department has issued fire orders against school buildings to the number of several hundred, of which only a few have been attended to. On the other hand, the executive and school authorities defend the schools as being safe, and state that lack of money has prevented them from making improvements in response to orders of the fire-prevention bureau of the fire department. The superintendent of schools has defended the schools by saying that while several fires have occurred in them, no life has been lost. It is reported that fire experts will make an inspection of the school buildings for the city.

Claim For Extras on the Panama Lock Gates is made on behalf of the contractors, McClintic-Marshall Construction Co., by Senator Oliver, of Pennsylvania, who has brought the matter before the Senate appropriations committee. The claim, amounting to more than $2,000,000, is supposed to rest on excessively severe inspection which resulted in more costly work to no useful end. As the matter is presented in the form of a Congress bill for compensation, reference to the Court of Claims is apparently not sought. A Pittsburgh dispatch to the New York "Times" purports to give some of the

grounds for the claim for extra compensation. It alleges that two gates were rejected after complete erection, that a gate-leaf was condemned because the rivet rows were not in perfect alignment, etc. In answer to our request for a statement of the engineering side of the case, the company declines to say anything about the matter.

Discarding of Macadam Roads Urged by New York State Governor. In a special message to the state legislature on Mar. 23, Governor Glynn, of New York, urged that no more macadam roads be authorized and that only one type of pavement be hereafter used on state highways, namely, vitrified brick. The Governor further recommended that the brick be manufactured in the state prisons. An appropriation for establishing an experimental brick-making plant at the Elmira Reformatory was asked for. As quoted in the New York "Times" of Mar. 24, the Governor's message stated:

Unless the State makes a radical change in the type of road it builds, it will cost from $20,000,000 yearly to maintain and rebuild New York's highways when the present system is completed. This is the real highway problem.

One hundred million dollars has been voted for the construction of New York's highways. If the roads we build in the future cost as much as those we have been building it will require an additional $30,000,000 to complete the proposed system. On New York's 12,000 miles of macadam roads the annual maintenance will be $12,000,000, the total cost of the roads will be $130,000,000, and at the end of ten years from the date of completion the State will have little to show for an expenditure of $250,000,000. In the 20 years thereafter the tax for highways will be at least $20,000,000 each year if our roads are to be kept in proper condition.

In other words, New York must either change its road policy or prepare to levy a perpetual yearly road tax of $2 on every man, woman and child within its borders.

A Complimentary Dinner to Prof. Ira O. Baker, Professor of Civil Engineering of the University of Illinois, was given at the La Salle Hotel, Chicago, on Mar. 17, to celebrate his 40 years of teaching at that institution. About 450 engineers and others (including many alumni) were present at the dinner, which was preceded by a reception. The toastmaster was William D. Pence, now on the Engineering Board of the Interstate Commerce Commission, and the principal speakers were President Edmund J. James, of the University; Clarence H. Blackall, one of the early graduates of the University; Hunter McDonald, President of the American Society of Civil Engineers; Edward H. Lee, President of the Western Society of Engineers; Prof. Henry S. Jacoby, Vice-President of the Society for the Promotion of Engineering Education; John J. Harman, President of the Illinois Society of Engineers and Surveyors; Edwin F. Wendt, retiring President of the American Railway Engineering Association; Prof. Arthur N. Talbot, President of the American Society for Testing Materials; and Lincoln Bush and Warren R. Roberts, of the civil-engineering alumni.

Plans and Specifications for 54 Dams were approved by the Conservation Commission of New York State during 1913, according to its annual report for that year. Of the structures covered by these plans, 18 were new and 36 were to replace dams which had become unsafe. During the year, 68 dams were inspected by the Commission and ordered strengthened or improved. Dam failures during the year numbered 17, but none of the structures were large or important. The commission states that:

Before the construction of any new dam is started, sites and foundations thereof are carefully examined, and other inspections are made from time to time during construction. . . . No dams built under plans and specifications approved by the commission have failed. Supervision by the commission has not only protected human beings and property from flood caused by the failure of dams, but has proved of great advantage to the owners of dams. The loss to owners and the cost of reconstructing dams which have failed by reason of improper design or defective construction, which amounted to large sums in the past, are believed now to be almost eliminated as a result of this supervision.

The Prevention of Sewer Explosions by thorough ventilation is the aim of the Division of Sewers of Springfield Mass. H. O. Buck, Deputy Superintendent of Sewers, o Springfield, Mass., has kindly sent us a copy of a letter which he wrote to an engineer asking for information on this subject. We reprint the letter as follows:

We have been very fortunate to date in having practically no sewer explosions, due in a great measure, I believe, to the fact that our sewer system is very well ventilated, the outlets at the river being open to the air and a large proportion of our catch-basin connections being untrapped, which allows the air to circulate freely.

Investigation has shown a strong current of air in most of our trunk sewers. We have in a number of cases detected the odor of illuminating gas escaping through our catch-basin connections and have been able to remedy the trouble without accidents occurring.

The gasoline problem, however, has given us considerable concern and we are very careful about sending men into the sewers on that account, at least two manhole covers being off and lighted lanterns lowered, before the men are allowed to go down. The distance between manholes averages about 300 ft.

A Guy Rope Snapped on a 30-Ton Derrick while erecting steelwork for the second and third floors of the Equitable Building under construction by the Thompson-Starrett Co., on Broadway, between Pine and Cedar St., New York City, in the early afternoon of Mar. 20. The derrick was situated on the second floor, near Broadway. It had picked up a 13-ton column from the second floor and had entered it in the splice plates when a guy-rope parted. The additional strain evidently ruptured a second. The boom and mast fell on the second-floor steelwork. The column flopped over on the upper deck of the sidewalk bridge, which was near the second-floor level, broke through and entered a construction shanty on the first deck, below, killing one workman and seriously injuring three others. The column stopped at this point. Had it not been for the lower bridge, the loss in life would probably have been greater as this part of Broadway is in the financial district and is thronged with pedestrians at this time.

The derrick was of steel with a 76-ft. mast and a 65-ft. boom. It was guyed with eight 1¼-in. plow-steel cables of which two were snapped near the top or spider. A third was broken, evidently by the fall of the mast and boom. The derrick was bought for use on the erection of the Municipal Building and was used later on the Woolworth Building, both in New York City. On the present site it has handled loads of 32 tons. About two weeks ago this same derrick fell a distance of about six feet while being lifted to position. It is said, however, to have been dismantled at the time. The guy ropes, therefore, apparently were not damaged by this fall.

Litigation Over Meter and Fire Protection Charges of the Pennsylvania Water Co., of Wilkinsburg, Penn., has been decided by the State Supreme Court in favor of the company after several years' litigation. The point of greatest general interest is that the company has won its contention for a fire protection charge of $275 per mile of distribution main, plus a "nominal charge" of $15 per fire hydrant. W. C. Hawley, chief engineer and general superintendent of the company just named, has sent us the following comment on the case, which embodies an interesting quotation from the decision of the lower court, now confirmed on appeal:

"I would call your attention, particularly, to the method of charging for fire protection which has been approved by the courts of this State, namely, an annual rate per mile of distribution pipe system within the municipality plus a nominal rate per year per hydrant. This latter rate is merely sufficient to cover interest, maintenance(depreciation and taxes on the fire hydrants. In discussing this matter, the Court of Common Pleas in its opinion stated:

'The results reached, based upon the analysis and theories testified to by Metcalf and Pence, as to the share which fire protection should bear to the whole, seem to be well founded. One of the gross inequalities existing heretofore, has been the small amount paid for this service, which has been based upon an arbitrary price per hydrant, instead of a nominal charge for each hydrant, plus a charge on the basis of each mile of distribution . . . . the former amounts paid were wholly inadequate; the arbitrary amount . . . . fixed partly upon hydrant charges, and partly upon distribution at the rate of $275 per mile, will justly bear an increase; . . . . It is manifest that this charge for fire protection and other public service cannot be based upon the quantity of water consumed, but upon an equipment and capacity, "standing ready to serve." Inadequate fire protection, easily in a few hours' time, can cost many times more loss to these eight Boros and the inhabitants thereof, than the most inflated values put upon the defendant's property

"The Wisconsin Railroad Commission, in the Green Bay case (decided in October, 1913) has adopted a rate of 7c. per lin.ft. per year for all future extensions plus a similar nominal rate per hydrant per year."

In the Pennsylvania Water Co. case, we may add, the court fixed the meter rate charge for the first 20,000 cu ft. within six months at 20c. per 100 cu.ft., with a minimum charge of $5 for six months' supply, which entitles the consumer to 2500 cu.ft. of water within that period. Wilkinsburg, Turtle Creek and a number of other boroughs were involved in the litigation. The valuation of $2,750,000 placed on the plant by the trial court was upheld, notwithstanding the claim of the company that this was $600,000 too low and of the boroughs that it was $600,000 too high.

Water Was Turned Into the Collapsed Antelope Valley Siphon, Los Angeles Aqueduct, on Mar. 19. We are informed by Wm. Mulholland, Chief Engineer, Los Angeles Aqueduct, that:

The pipe, as anticipated, rounded up perfectly. Not to exceed 30 rivets were sheared or otherwise broken at the sharpest lines of deformation. The leakage now (Mar. 24) is very slight and will be calked completed in a few days. The Collins rain gage, within two miles of Antelope siphon, registered 11.6 in. for storm [of Feb. 18-20, which preceded the collapse].

Mr. Mulholland also states that a week's delay on the repairs was caused by a shipment of steel but strap and other material going astray on the railroad. A description of the collapse of this 10-ft. riveted steel siphon, by Mr. Mulholland, appeared on p. 581 of our issue of Mar. 12, 1914.

Wind Blew Down a Wall of the Gutted Missouri Athletic Club, St. Louis, Mo., on Mar. 17, eight days after the fatal fire ("Eng. News, Mar. 12). The three upper stories of the west wall fell upon an adjacent four-story seed store, demolishing it and killing seven persons and injuring a number of others. Although the walls of the club were plainly unsafe, the seed store was permitted to remain "open for business" (as a large sign on its front announced). Since, it has been attempted to pull down the remaining charred walls by means of cables pulled by street cars. The force thus exerted was insufficient and resort was had to dynamite.

PERSONALS

Mr. Sheldon K. Baker, Assoc. M. Am. Soc. C. E., has resigned as Assistant Engineer, United States Reclamation Service, Phœnix, Ariz.

Mr. W. H. Beardsley, Vice-President and Treasurer of the Florida East Coast Ry., has been elected President to succeed the late R. W. Parsons.

Mr. James S. Harlan, a member of the Interstate Commerce Commision since 1906, has been elected Chairman, succeeding Mr. Edgar Clark.

Mr. R. H. White, recently Assistant Signal Engineer of the Louisville & Nashville R.R., has become Editor of "The Signal Engineer," Chicago, Ill.

Mr. J. A. Gordon, formerly General Superintendent of the Western district of the Pere Marquette R.R., has been appointed General Manager of the Chicago, Great Western R.R.

Mr. H. A. Rapelge has been appointed Sales Engineer of the Pittsburgh district of the Terry Steam Turbine Co., of Hartford, Conn., with offices at 2123 Oliver Bldg., Pittsburgh, Penn.

Mr. J. Russell, General Superintendent of the Great Northern Ry., at Seattle, Wash., has resigned to become General Manager of the Denver & Rio Grande R.R., with headquarters at Denver, Colo.

Mr. D. J. Mullen, Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis R.R., at Mattoon, Ill., has been promoted to be Superintendent of Motive Power, with headquarters at Indianapolis, Ind.

Mr. Auguste Glauden, Chief of Division, Ministry of Railways of Belgium, is making an exhaustive study of railway operation in this country for the purpose of making improvements in the Belgian methods.

Mr. R. Preston, Master Mechanic of Canadian Pacific Ry., at Winnipeg, Man., has been promoted to be Assistant Superintendent of Motive Power of the lines west of Winnipeg, with headquarters at Winnipeg.

Mr. A. E. Chodzko, Consulting Engineer of the Sweetwater Water Co., San Diego, Calif., since the death of James D. Schuyler, M. Am. Soc. C. E., has opened offices in the Phelan Bldg., San Francisco, Calif., for general practice.

Mr. W. T. Martersteck, of Youngstown, Ohio, has been appointed Engineer in charge of the $1,500,000 addition to the Massillon Rolling Mills, Massillon, Ohio. He was formerly Chief Engineer of the Sharon Steel Hoop Co., Youngstown.

Brig.-Gen. William T. Rossell, recently retired as Chief of Engineers, U. S. A., has been appointed Advisory Engineer to assist Mr. John C. Carlisle, State Highway Commissioner of New York, in matters relating to engineering in the administration of the highway department.

Dr. W. M. Leiserson, former State Superintendent of Employment Offices in Wisconsin, has been engaged by the United States Commission on Industrial Relations to take charge of its investigation into irregularity of employment and to assist in formulating recommendations for remedial legislation.

Mr. W. A. Hanscomb has withdrawn from the firm of Hanscomb, Jones & Reddick, Consulting Engineers, Monadnock Bldg., San Francisco, Calif., to engage in independent practice. Mr. J. B. Hally, who has been associated with the firm for a number of years, has been made a member of the firm, to succeed Mr. Hanscomb.

Mr. William C. Willard, Assoc. M. Am. Soc. C. E., recently Assistant Engineer, Panama Pacific International Exposition Co., San Francisco, Calif., has been appointed Assistant Professor of railway engineering at McGill University, Montreal, Que. Mr. Willard had charge of the design [illegible] system of the exposition.

Governor John K. Tener, of Pennsylvania, has been elected an honorary member of the Engineers' Society of Pennsylvania. Mr. C. E. Turner, of the Pennsylvania Steel Co., proposed the action which was approved by [illegible] ballot, "in recognition of the Governor's recommendation of legislation for the advancement of the profession."

Mr. Edward C. Gillette, Assistant Engineer, United States Lighthouse Service, has been appointed Superintendent of the Naval Construction of the Service, succeeding Mr. George Warrington. Mr. Gillette was formerly Inspector in charge of the Second district of the Lighthouse Service. Previous to 1912 he was largely engaged in the construction and repair of vessels for the Service.

Mr. F. Herbert Snow, M. Am. Soc. C. E., recently Chief Engineer of the Pennsylvania State Department of Health, has been appointed Chief Engineer of the new Pennsylvania Public Service Commission, and will soon begin organization of a bureau of engineering. Mr. Snow is a graduate of Penn State University and was formerly a member of the firm of Snow & Barbour, of Boston, Mass.

Prof. Samuel Sheldon, Professor of Physics and Electrical Engineering, Brooklyn Polytechnic Institute, was tendered a testimonial dinner at the Hotel Astor, New York City, on March 21, in celebration of his 25 years of service at this institution. The speakers reviewed Professor Sheldon's work as a teacher, and his contributions to electrical engineering, besides giving many reminiscences of his "boys."

Mr. Harold McL. Lewis, Jun. Am. Soc. C. E., recently with Mr. George W. Fuller, M. Am. Soc. C. E., Consulting Engineer, New York City, has accepted a position with the engineering staff of Dr. Karl Imhoff, at Essen, Germany. Mr. Lewis is a graduate of Rensselaer Polytechnic Institute, class of 1912, and is a son of Mr. Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment, New York City.

Mr. E. M. Durham, Jr., recently Principal Assistant Engineer of the Southern Ry., at Birmingham, Ala., has been appointed Special Examiner of the Atlanta, Birmingham & Atlantic R.R., in charge of valuation work. Mr. Durham was born at Memphis, Tenn., in 1875, and educated at Lehigh University. He has been with the Southern Ry. since 1900, previous to which he was for one year with the Chicago & Northwestern Ry.

Messrs. Norman M. Halcombe, Assoc. M. Am. Soc. C. E., formerly with Duryea, Haehl & Gilman, of San Francisco, Calif.; A. E. Flanders, for the past three years with the geological department of the Associated Oil Co.; and Bill Read, Jun. Am. Soc. C. E., have formed a partnership under the firm name of Halcombe, Flanders & Read, Civil and Mining Engineers, with offices in the Phelan Bldg., San Francisco, Calif. Mr. Read is at present engaged in geological work for the Belgian Government in the Congo, East Africa.

Mr. C. H. Gerber has resigned as Chief Engineer of the Nebraska State Railway Commission, effective on or before May 1, in order to devote his whole time to private practice, as a member of the firm of Hurd, Gerber & Wettling, Consulting Engineers, of Chicago, Ill., and Lincoln, Neb. Mr. Gerber was with the engineering department of the Union Pacific R.R. until 1909, when he was appointed Principal Assistant Engineer of the Nebraska Railway Commission. He has been Chief Engineer since November, 1913, when Mr. E. C. Hurd resigned.

Mr. Wilbur M. Bosworth, M. Am. Soc. M. E., has been appointed Mechanical Engineer of the Louisville & Nashville R.R. He was born in Baltimore, Md., June 13, 1879, and graduated from the Baltimore Polytechnic Institute in 1898. His railway experience began the same year as a special apprentice at the Mt. Clare shops of the Baltimore & Ohio R.R. Later he was draftsman and Chief Draftsman. In 1911 he was appointed Mechanical Engineer of the Kansas City Southern Ry., at Pittsburg, Kan., which position he resigned to go to Louisville, Ky., Mar. 1.

Mr. Paul E. Kressly, City Engineer of Inglewood, Calif., has been appointed City Manager of Inglewood, in addition to his engineering work. Mr. Kressly is 32 years old and has been City Engineer for two years; previous to three years ago he was in private practice in South Bethlehem, Penn., serving also as Borough Engineer of Nazareth, Fountain Hill and Freemansburgh, Penn. Inglewood is the first city on the West Coast to adopt the city-manager plan of municipal government. The new ordinance provides for a Board of Trus-

tees of the city, who appoint a City Manager, to hold office at their pleasure, and all of whose acts are subject to the approval and control of the Board.

The engineering department heads for the permanent organization of the Panama Canal operating staff have been appointed as follows:

Governor and Chief of the Department of Operation and Maintenance, Col. George W. Goethals, M. Am. Soc. C. E. Corps of Engineers; Engineer of Maintenance, Col. Harry F. Hodges, M. Am. Soc. C. E., Corps of Engineers; Superintendent of Transportation, Capt. Hugh Rodman, U. S. N.; Electrical Engineer, Capt. W. H. Rose, Assoc. Am. Inst. C. E., Corps of Engineers; Captains for the Terminal Ports, Commander Douglas E. Dismukes and Lieut.-Commander Henry V. Butler, U. S. N.; Superintendent of Shops and Drydocks, Naval Constructor Daniel C. Nutting, Jr.

Mr. Gerard H. Matthes, M. Am. Soc. C. E., recently Principal Assistant Engineer of the hydro-electric department of the American Water Works & Guarantee Co., Pittsburgh, Penn., has been appointed Engineer in charge of Flood Inventory of the Water Supply Commission of Pennsylvania, with office at Harrisburg, Penn. His duties will have to do chiefly with the preparation of that portion of the forthcoming report on the water resources of Pennsylvania which deals with the flood problem. For over 10 years Mr. Matthes was engaged in stream gaging and irrigation work for the United States Geological Survey and the United States Reclamation Service. For the past seven years he has been in the employ of corporations developing extensive water powers.

Mr. B. T. Elmore, whose appointment as Engineer of Roadway and Track, Division of Valuation, Interstate Commerce Commission, with headquarters at Washington, D. C., was noted in our issue of last week, was born at Mobile, Ala., Dec. 14, 1866. He graduated in civil engineering from the University of the South and commenced his engineering experience in 1886 as a rodman on railway location and preliminary surveys. For 13 years he was engaged in railway work in Alabama, Georgia, Tennessee, South Carolina, Virginia, West Virginia and New York. From 1899 to 1901 he was Resident Engineer on surveys and construction of the Baltimore & Ohio Southwestern R.R. in Indiana. For the past 12 years Mr. Elmore has been Locating Engineer, Engineer of Surveys, Assistant Chief Engineer and Division Engineer of the Virginian Ry.

Mr. Thomas B. Purves, recently engaged by the Massachusetts Railroad Commission in railway appraisal work, has been appointed Senior Mechanical Engineer of the Eastern district, Division of Valuation, Interstate Commerce Commission, Washington, D. C. He was born at East Albany, N. Y., Jan. 4, 1858. After receiving a good elementary education and an apprenticeship in the mechanical department of the Boston & Albany R.R. he served as locomotive fireman, engine-house foreman, General Foreman, Master Mechanic and Superintendent of Motive Power and Machinery. He resigned in 1904 to join the staff of the Boston & Maine R.R., for which he served as a member of the Board of Appraisal to determine the value of the Fitchburg R.R. In 1906 Mr. Purves was appointed Superintendent of Motive Power and Machinery of the Denver & Rio Grande R.R., where he remained until 1909.

Mr. Louis C. Fritch, M. Am. Soc. C. E., has resigned as Chief Engineer of the Chicago Great Western R.R., to become Assistant to the President of the Canadian Northern Ry., Sir William Mackenzie, with headquarters at Toronto, Ont. Mr. Fritch was born in Springfield, Ill., in 1868 and studied civil engineering at the University of Cincinnati. Subsequently he studied law and was admitted to the Ohio bar. His engineering experience began in 1884 on the Ohio & Mississippi Ry.; he was made Engineer of Maintenance-of-Way, in 1892. Later he was Division Engineer and Division Superintendent of the Baltimore & Ohio Southwestern R.R., which absorbed the Ohio & Mississippi Ry. From 1904 to 1909 he was with the Illinois Central R.R. as Assistant to the General Manager, Assistant to the President and Consulting Engineer. Since 1909 he has been Chief Engineer of the Chicago Great Western Ry.

Mr. C. G. Delo, Engineer of Maintenance-of-way of the Chicago & Great Western R.R., at Chicago, Ill., has been promoted to be Chief Engineer, succeeding Mr. Louis C. Fritch, M. Am. Soc. C. E., resigned, as noted eleswhere in these columns. Mr. Delo was born in 1866 and was educated at the Kansas State University and Cornell College. Later he was Assistant Engineer and Division Engineer of the Burlington, Cedar Rapids & Northern Ry., at Cedar Rapids, Iowa; Principal Assistant Engineer of the Chicago, Rock Island & Pacific Ry., at Chicago, Ill.; Engineer of Maintenance-of-way of the Chicago & Alton Ry. at Kansas City, Mo., and Engineer of Maintenance-of-way of the National Rys. of Mexico, at Mexico City. Previous to March, 1910, when he was appointed Engineer of Maintenance-of-way, he had served for short periods as Divison Engineer of the Chicago Great Western R.R.

Mr. Morris A. Zook, M. Am. Soc. C. E., Consulting Engineer, of Plainfield, N. J., recently engineer in charge of the valuation of the Grand Trunk-Wabash joint lines in Canada, has been appointed Resident Engineer, Division of Valuation, Interstate Commerce Commission, with office at Washington, D. C. Mr. Zook was born in Philadelphia, Penn., in 1859, and graduated from the Pennsylvania Polytechnic College there in 1879. After a few months as a draftsman he was successively Assistant Engineer, Resident Engineer and Chief of Location on the Shenandoah Valley R.R. and the Norfolk & Western Ry. For seven years following 1883 Mr. Zook was with the Pennsylvania R.R. Lines West of Pittsburgh. Subsequently he was with the engineering departments of various other railways in the Middle West. From 1902 to 1904 he was Engineer in charge of reconstruction of the L. & S. division of the Central R.R. of New Jersey. Since 1904 he has been in private practice, mostly in railway valuation work.

Mr. Warrick R. Edwards, M. Am. Soc. C. E., whose appointment as Senior Structural Engineer of the Eastern district, Division of Valuation, Interstate Commerce Commission, was noted in our issue of last week, was born at Kirkwood, Mo., Feb. 8, 1869. He graduated in civil engineering at Washington University, St. Louis, Mo., in 1888, and after a year in bridge department of the city of St. Louis he entered the employ of the late George S. Morison, Past-President, Am. Soc. C. E., as a rodman on the construction of the famous Mississippi River bridge at Memphis, Tenn. Later he served as shop inspector on the superstructure of the bridge. After two years, 1892-1894, as a draftsman in the bridge and construction department of the Pencoyd Iron Works, Philadelphia, Penn., Mr. Edwards entered the service of the bridge department of the Baltimore & Ohio R.R. as an inspector. He was promoted through various grades to be Assistant Engineer of Bridges, which position he recently resigned to accept his present office.

OBITUARY

Frederick T. Beebe, Superintendent of Construction for Doyle & Co., Contractors and Builders, of Philadelphia, Penn., died Mar. 15.

Dr. W. T. Dutton, Professor of mathematics and civil engineering at Allegheny College, died Mar. 19. He was President of the college in 1909-'10.

William H. Thomas, former Superintendent of Motive Power of the Southern Ry., died Mar. 7, at his home in Philadelphia, Penn. He was born Sept. 27, 1842.

Thomas M. Connors, Superintendent of the Hocking Valley Ry., Columbus, Ohio, died Mar. 18, at Toledo, Ohio. He was formerly Superintendent of the Kanawha & Michigan Ry.

Aaron Van Guysling, 88 years old, a pioneer railway builder of New York State, died at Los Angeles, Calif., Mar. 8. He is said to have been a railway contractor on the Mohawk & Hudson River R.R. in the decade before the Civil War.

Edwin M. Coryell, M. Am. Soc. M. E., Consulting Engineer, New York City, died from heart disease in his office at 11 Broardway, Mar. 23. He was in his 66th year and had been for many years Consulting Engineer for the Cameron Steam Pump Works of New York City.

James W. Thomson, Chief Engineer, U. S. N., retired, died at his home in Moorestown, N. J., Mar. 17 . He was born in Wilmington, Del., Nov. 10, 1836. He was appointed Third Assistant Engineer in the United States Navy in 1856, and was promoted until he was Chief Engineer in 1862. He was retired in 1896 with the rank of Rear-Admiral.

Augustus Henry Ward Johnson, President of the Pulsometer Steam Pump Co., New York City, died at his home at Larchmont, N. Y., Mar. 16. He was educated at Stevens Institute of Techmology and was well known as an inventor and engineer. He had been connected with the Pulsometer Steam Pump Co. for many years. Mr. Johnson was distinguished outside of his profession as a yachtsman.

William A. Hunicke, M. Am. Soc. C. E., former Chief Engineer of the Louisiana & Northwest Ry., of Homer, La., was among those who lost their lives in the fire at the Missouri Athletic Club house, St. Louis, Mo., Mar. 9. He was born in St. Louis and was a graduate of Washington University there in 1897. Recently he had been with the engineering staff of

the Missouri Pacific Ry., and had made his home at the club. He was 39 years old and unmarried.

George W. Hendrick, at one time a well known New England contractor, died Mar. 19, at his home in Easthampton, Mass. He was 85 years old. He began railway work at the age of 16 years by taking charge of the horses in a construction camp. He was made foreman and when still a young man entered business for himself as a contractor. He built many miles of early New England railways and also carried out extensive contracts in sewer and water-supply construction.

Edmond Bonner Temple, M. Can. Soc. C. E., died at his home in Toronto, Ont., Mar. 18. Until a year ago he was Harbormaster of Port Arthur, Ont. He studied civil engineering at the Quebec High School, and when a student was employed on the Montmorency bridge, which collapsed during construction. Later he was with the engineering departments of the Grand Trunk Ry. and the Canadian Pacific Ry. For many years he was in the employ of the Dominion Government at Toronto. He had been a member of the Canadian Society of Civil Engineers since 1889.

Edward Bourne Gibbs, a railway mechanical engineer in the early days of western railways, died in St. Louis, Mo., Mar. 5, aged 80 years. He was born in Barnstable, Mass., and served an apprenticeship in the Taunton Locomotive Works, Taunton, Mass. He went West and was employed on the construction of the Hannibal & St. Joseph R.R., one of the first railways in Missouri. In 1863 he was made Manager of Power and Rolling Stock of the Platte County R.R., now a branch of the Kansas City, St. Joseph & Council Bluffs R.R. He went to St. Louis in 1868 as Master of Machinery and Motive Power of the St. Louis & Iron Mountain R.R. From 1880 to 1904 he was employed in various capacities in the mechanical and operating departments of the Union Pacific R.R.

Chas. A. Morris, whose death on Mar. 8, at Los Gatos, Calif., was briefly noted in our issue of last week, was widely known as an authority on dredging. He was a grandson of Ephraim Morris, the originator and inventor of the clam-shell bucket, the inclined plane for canals, and other devices. He was the son of Augustus T. Morris, of the Morris & Cumings Dredging Co., so he came naturally by his specialty of dredging. After studying for a time at Stevens Institute of Technology he joined the engineering staff of the Morris & Cumings Dredging Co. While engaged in this work he met and formed a strong friendship with John P. Holland, inventor of the Holland submarine boat, and assisted him in the construction of his first boat. Mr. Morris was later instrumental in introducing suction dredges on the Pacific coast. For a time he was connected with the Munson Steamship Co., and helped to solve many of the company's problems in freight handling at Cuban and other ports. He was the inventor of a coal-handling bucket and other conveying apparatus. At the time of his death he was Consulting Engineer of the Hayward Co., New York City, where his principal work had been on the development and improvement of buckets.

ENGINEERING SOCIETIES

COMING MEETINGS

EFFICIENCY SOCIETY.
Apr. 4-11. First annual conference in New York City. Offices at 41 Park Row, New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 16-18. Spring meeting in New York City. Secy., Prof. J. W. Richards, Lehigh University, Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Apr. 22-25. Annual meeting at Savannah, Ga. Secy., J. R. Gray, Chamber of Commerce, Savannah, Ga.

IOWA STREET AND INTERURBAN RAILWAY ASSOCIATION.
Apr. 22-25. Annual meeting at Waterloo, Iowa. Secy., H. E. Weeks, Tri-City Ry. & Light Cos., Davenport, Iowa.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 5-7. Annual meeting in Chicago, Ill. Secy., Franklin H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 5-8. Convention at Detroit, Mich. Secy., F. M. Nelis, 53 State St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-15. 34th Convention at Philadelphia, Penn. Secy., J. M. Diven 47 State St., Troy, N. Y.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 18-21. 6th convention in Chicago, Ill. Secy., C. G. Hall, C. & E. I. R.R., 922 McCormick Bldg., Chicago, Ill.

MASTER BOILER MAKERS' ASSOCIATION.
May 25-28. Convention at Philadelphia, Penn. Secy., H. D. Vought, 95 Liberty St., New York City.

Boston Society of Civil Engineers—The Board of Government has established an employment bureau wherein two lists are kept on file, one of positions available and the other of men available, giving in each case detailed information.

Vermont Society of Engineers—The second annual meeting was held at the Hotel Vermont in Burlington, Mar. 12. At the business session, the Committee on Public Policy recommended that the Society take such steps as necessary in order to lay before the Governor of the State matter of appointment of at least one engineer on the Public Service Commission. This committee also reported that the office of State Engineer should be created. Both recommendations were adopted. At the afternoon meeting State Forester A. F. Hawes read a paper entitled, "The Influence of Forests on Water Storage and Stream Flow." J. K. Dinger, the local forecaster, spoke on "Rainfall"; and Professor Votey, of the University of Vermont, on "Water Resources and Storage." Following the banquet, Prof. Geo. H. Perkins gave an address on the "Geology of the Green Mountains." The officers for the ensuing year are as follows: President, D. Williams, of St. Johnsbury; Vice-President, H. M. McIntosh, of Burlington; Secretary, G. A. Reed, of Barre.

Philadelphia Association of Members of the American Society of Civil Engineers—The new address of the Association, which was recently formed ("Engineering News," Mar. 12), is 1317 Spruce St. The Secretary is W. F. Stephenson, Room 412, City Hall, Philadelphia, Penn.

Boston Society of Civil Engineers—The 66th annual meeting of the Society, which now numbers 837 members, was held at the City Club on Mar. 18. Coöperation with the local sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers was discussed and the Board of Government was directed to appoint a committee of three to consider this. The annual dinner, which was served at 2 p.m., was followed by an illustrated talk on "City Planning From the Standpoint of the Engineer," by Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City. Mr. Lewis stated that the responsibility of the engineer for the welfare of the cities had only recently been recognized. Engineers once did things when they were told, as they were told and because they were told; now, however, they are responsible for shaping public policies. He said that the elements of city planning are (1) transportation; (2) recreation systems, and (3) public buildings.

The officers elected were President, Harrison B. Eddy; Vice-President, Richard A. Hale; Secretary, S. E. Tinkham, Tremont Temple, Boston; Treasurer, C. W. Sherman; Directors, for two years, C. M. Allen and L. C. Watson.

The Desmond-Fitzgerald medal was presented to G. A. Hartwell for his paper on the Fitchburg sewerage system. The usual smoker was held in the evening.

American Institute of Electrical Engineers—The Board of Directors has selected the following ticket from the tellers' report of the recent letter ballot for nominations before the coming annual election: For President, Paul M. Lincoln, Pittsburgh; for Vice-Presidents, F. S. Hunting, Fort Wayne, Ind., N. W. Storer, Pittsburgh; Farley Osgood, Newark, N. J.; for Managers, Frederick Bedell, Ithaca, N. Y., Bancroft Gherardi, New York City, John H. Finney, Washington, D. C., A. S. McAllister, New York; for Treasurer, George A. Hamilton, Elizabeth, N. J.

British Columbia Association of Gas Engineers—At the recent second annual meeting of this Society, the following officers were elected: President, J. E. Gale; Treasurer, W. Stark; Secretary, F. H. Chappell, Vancouver, B. C.

Exhibit of Better Industrial Relations—This exhibit will be held Apr. 18-25 at 2 West 64th St., New York City, under the auspices of the Society for Ethical Culture. It will show the devices in modern business which tend to improve the relations between employer and employee. The exhibit will be divided into three parts: (1) Relations between employer and employee; (2) improving conditions in individual establishments; (3) associations of employees. Address J. R. Rankin, 2 West 64th St., New York City.

American Boiler Manufacturing Association—The 26th annual convention will be held Sept. 1-4 at the Waldorf-Astoria Hotel, New York City. The Secretary is F. B. Slocum, West & Calyer Sts., Brooklyn, N. Y.

International Congress of Consulting Engineers—The second congress will be held at Berne, Switzerland, June 25-30. It is proposed to hold the third congress at San Francisco in September, 1915, coincident with the Panama-Pacific Exposition.